DISEASES *of the* CHEST

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INTRODUCTION

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The invisible rays discovered by Roentgen in 1895 are recorded on one of the most brilliant pages of the annals of medical history. This epoch-making discovery has maintained its radiant influence upon medical science ever since. The subsequent phenomenal developments in the field of roentgenology during the past half a century could not have been envisaged by the most daring mind of his age. The outstanding technical and scientific achievements in roentgenology are ably discussed in the contribution of Morgan and Lewis. As an adjunct to this, perhaps it may not be amiss to review some of the clinical aspects of roentgenology as related to diseases of the chest.

Roentgenological studies of recent years have vindicated the postulate of Parrot (1876), according to which a tuberculous involvement of the lymphnodes at the root of the lung is always an indication of a coexistent or foregone tuberculosis of the pulmonary parenchyma. At the same time, the validity of the concept of Behring (1912) that "phthisis is but the last verse of the song, the first verse of which was sung to the infant at its cradle," has lost much of its standing through combined investigations with the roentgen ray and the tuberculin skin test. By periodically repeated roentgenograms of the chest we have been able to follow the course of pulmonary tuberculosis from its inception to its complete healing by calcification. Further roentgenological studies confirmed earlier observations that lesions of the reinfection type of tuberculosis often heal by calcification. Extensive investigations conducted by the U. S. Public Health Service during the past few years brought to light the startling information that in a rather high percentage of cases calcified pulmonary nodules were not due to tuberculosis but rather to healed infection with histoplasma capsulatum. In passing, it may be recalled that pulmonary aspergillosis and coccidioidomycosis may heal also with pulmonary calcification. In this connection, reference should be made to

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the roentgenological and pathological findings of Salinger (1932) which illustrated the occurrence of numerous nodular calcified areas in the lower lung fields in rheumatic mitral stenosis.

All those who are engaged in the diagnosis of diseases of the chest appreciate the valuable suggestions given in Brown's paper in this issue. There cannot be any question that positioning the patient during fluoroscopy and prior to taking roentgenograms may reveal findings which are not visible in the standard position. Another useful method of obtaining more accurate roentgenographic details of the lungs was proposed by Deutschmann (1934). By tilting the tube, 35 degrees up or down while it is focused on the apex, one is enabled to identify apical lesions which are not visible on the ordinary chest film. Roentgenograms taken with the patient in the lordotic position have also proved their usefulness for a more detailed visualization of the upper segments of the lung.

The comprehension and interpretation of pulmonary lesions localized to comparatively small anatomical segments of the lung, as presented in the work of Foster-Carter and Hoyle, is a gratifying revelation indeed. Undoubtedly, the time and effort sacrificed for the elucidation of this particular subject will be richly rewarded by the practical application of these observations in the diagnosis of pulmonary diseases as well as in their medical and surgical treatment.

The portrayal of the length and width changes of the vessels of the lesser circulation as presented by Macklin in this issue have an important bearing on the mechanism of the therapeutic action of the so-called conservative relaxation measures used in pulmonary tuberculosis. These studies enhance and clarify the angiopneumographic research of Carvalho (1940). It seems that there is a never-ending opportunity for the scientifically inclined inquisitive mind to discover new facts concerning the complex workings of the body in health and disease. We are reminded here of the remarkably instructive investigations of Hudson and Jarre (1929) and of Macklin (1925) which dealt with the changes in the size and shape of the bronchial tubes during respiration, and according to the concept of Macklin offered a rational explanation of the predilectional development of pulmonary tuberculosis in the so-called superior retroradical area. Subsequently, these observations were augmented by the contributions of Castex, Mazzei and Malenchini (1941). The results of their bronchocinematographic studies show that the normal bronchi have active respiratory movements which include, 1) changes in length and caliber, 2) peristalsis, 3) undulation, and 4) torsion.

A significant advancement in the field of roentgenology is re-

presented by the work of Hurtado and Fray (1933). They proposed to secure an accurate value of the true size of the chest cavity by a roentgenological method. Their assumption was that multiplying the area of the lung fields, measured in roentgenograms, by the antero-posterior diameter of the chest, measured externally—the so-called roentgenologic chest volume—would give a close approximation of the size of the thorax. They found that the correlation coefficient between the actual vital capacity and the roentgenological chest volume was higher than that between the vital capacity and body height, chest circumference, area of lung field, body surface area, and the chest volume based on external measurements, respectively. My own studies along these lines (1937) have convinced me of the reliability and usefulness of this method. The data of my protocols show that estimations of the vital capacity according to the formula of Hurtado and Fray were within $\pm$ 15 per cent of the actual vital capacity of the lungs in 97 per cent of 65 healthy individuals. As a by-product of the same investigation I noted that one could gain a reasonably close estimate of the respiratory functional capacity of a patient with silicosis or with silicosis and pulmonary tuberculosis by calculating the volume ratio of the lung: (roentgenological chest volume at maximum expiration divided by the roentgenological chest volume at maximum inspiration) times 100. With the exception of 2.5 per cent of the controls, the volume ratio was below 70 in forty healthy individuals, while in 60 per cent of the patients with pulmonary tuberculosis and silicosis, or silicosis alone the volume ratio was 70 or more.

An excellent exposition is presented in the article of Paul on neurogenic tumors at the pulmonary apex. Its differential diagnostic points deserve particular attention. This subject represents only a small fraction of neoplasms occurring in the lung and the mediastinum. There is incontrovertible evidence that the incidence of pulmonary cancer is on the increase. According to recent statistical reports, next to carcinoma of the stomach, pulmonary carcinoma is the most frequent carcinoma in the male. In its early developmental phases it may be entirely without manifest clinical symptoms. This being so, a great many patients reach the chest physician, the roentgenologist or the general practitioner when the carcinomatous process has already metastasized or encroached upon other vital organs and thus it has become inoperable. It seems to me, that it would be a highly desirable and justifiable project on the part of the medical profession to initiate and maintain a nationwide campaign for an annual roentgen examination of the chest (preferably by roentgenograms) of the entire adult population for the early detection of cancer.

Cardioangiography is one of the more recently popularized additions to diagnostic roentgenology. We are gratified by the presentation of this subject from the vast experience and with the critical evaluation of Taylor. The accompanying roentgenograms offer highly informative and didactic values. Roentgenography with the aid of contrast media has been of inestimable service in the diagnosis of pulmonary diseases. It is a matter of record that, in addition to its indispensable value in bronchiectasis, it may bring about direct or indirect evidence of bronchial stenosis, benign and malignant neoplasms, atelectasis, pulmonary abscess, congenital cystic disease of the lung, and others. Its usefulness for the visualization of bronchial ulcers was reported by Fariñas (1942) under the designation of bronchomucosography.

Garland's thoroughgoing study on intrathoracic metallic foreign bodies complements well the application of the roentgen ray in chest diseases as discussed by the other authors in this issue. In this connection, one may also proudly point to the diagnostic value of roentgenological examinations in nonopaque foreign bodies in the lung. The particular importance of films taken at the end of full inspiration and expiration must be kept in mind whenever such a diagnostic problem arises.

The presentation of de Abreu is of great interest because of its roentgenological and bacteriological aspects. Relative to the latter, since 1898 when Meunier first advocated the examination of the fasting gastric contents for tubercle bacilli, a number of publications brought confirmatory evidence of the usefulness of this diagnostic procedure. Therapeutic bronchial lavage was first suggested by Yankauer in 1914. The use of bronchial lavage for bacteriological examination, as described in de Abreu's article, is a significant contribution to the diagnosis of certain types of pulmonary tuberculosis.

The application of therapeutic roentgenology is well represented in this issue by the excellent analytical and critical review of Desjardin concerning the roentgen treatment of Hodgkin's disease and lymphosarcoma of the chest. There is a wide field of therapeutic roentgenology in chest diseases. There are items which are of no more than historical interest, such as roentgen irradiation of the lungs for pulmonary tuberculosis. On the other hand, the same method is still being used in the treatment of certain types of bronchiectasis. The use of roentgen therapy for bronchiectasis rests on the observation that irradiation of the salivary glands is followed by a substantial reduction in or a practically complete abolition of their secretory function. On the basis of analogy, it was thought that exposure of the lungs to roentgen rays may bring about a decrease in the secretion of the glands

of the bronchial mucosa. Also, it has been reasoned that roentgen therapy is beneficial because it may bring about a clearing of chronic inflammatory processes in the lung. It is generally accepted that no corrective morphological response can be expected from this treatment as far as bronchiectatic deformities are concerned. The greatest accomplishment of this measure lies in changing a "wet" bronchiectasis, with excessive cough and massive expectoration into a "dry" bronchiectasis, with markedly reduced cough and with virtual disappearance of expectoration. Two points are worthy of remembering in this connection: 1) An exacerbation of the symptoms can be anticipated during treatment. 2) Complete therapeutic benefits of the treatment may not become manifest in less than four months after the conclusion of the therapy.

No attempt has been made in this review to cover the entire field of roentgenology. It is beyond the scope and technical feasibility of this presentation. It has been my intention to focus attention on some of the highlights of this branch of medicine in harmony with the current articles of the contributors.

This commemorative issue of *Diseases of the Chest* is being published on the occasion of the one-hundredth anniversary of the birth of Roentgen and of the fiftieth anniversary of the discovery of the roentgen ray. It is being offered as a symbol of the respect, homage and tribute which all of us wish to pay to the genius of Roentgen. The joint presentation of contributions from various parts of the United States, from Canada, Great Britain, Brazil and other countries is a solid expression of the unity of scientific thought and endeavor. May this harmony and understanding bring about a closer cooperation among those who dedicate their professional efforts to the diagnosis and treatment of chest diseases so that we may anticipate still further progress and still greater achievements in this field of medical science.

The Roentgen Ray: Its Past and Future**

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. Few events have had a more profound influence on the practice of medicine than the discovery of the roentgen ray, the fiftieth anniversary of which we are celebrating this year. Almost from the day that Roentgen made his dramatic announcement to the world, physicians and physicists everywhere began work on the development of equipment to utilize this new radiation in the diagnostic and therapeutic fields of medicine.

The events which culminated in Roentgen's discovery on November 8, 1895, extend back to the Golden Age of Greece when observations were made of "electric" phenomena. However, from this time until the 17th Century this knowledge lay buried and it was only in 1600, when Gilbert[1] in England began the performance of a long and brilliant series of experiments, that the science of electricity was placed upon a firm foundation. Shortly thereafter, von Guericke began the study of electrical conduction through gases. These researches were continued through the 18th Century by Hawksbee, Dufay, Nollet, and Morgan. The equipment used in the experiments of two of these workers, Hawksbee and Morgan, had the potentiality of producing roentgen rays; indeed, in 1785, Morgan, it is generally assumed, produced such radiation, although its existence was unknown to him. During the 19th Century, the work of Faraday, Maxwell, Hertz, Hittorf, Crookes, and Lenard, to mention only a few, added still further to the knowledge of electrical conduction through gases. It was this research which prompted Roentgen[2] to begin his experiments (Figs. 1 and 2).

It is difficult to say whether Roentgen's discovery of the radiation which now bears his name and which he originally referred to as "X-rays," was the result of deliberate research or of mere chance. There is, however, abundant evidence that his findings were anticipated. It is known, for instance, that his final experiments were conducted in total darkness with a Crookes' tube that was covered with black cardboard to prevent the escape of visible light produced by the gaseous discharge within the tube. Furthermore, there was also present near the tube a small piece of cardboard impregnated with barium platino-cyanide which would only fluoresce when impinged upon by the radiation of wave lengths

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shorter than those to which the eye is sensitive. On the other hand, those who believe that the discovery was one of chance base their opinion on the fact that in the years following 1900, Roentgen made no significant contributions to the rapidly developing field of radiology.

The Crookes' tube, shown schematically in Figure 3, with which Roentgen performed his experiments, consisted of a glass envelope in which were sealed two metallic electrodes. The tube was evacuated to a low pressure (a fraction of a millimeter of mercury) and by means of an induction coil a high potential was impressed upon the electrodes. The small quantity of gas which remained

Figure 1

Figure 2

Fig. 1: Plaque commemorating Roentgen's discovery installed on outside of the scientist's laboratory in Wurzburg, Germany. Inscription reads: "In this building there were discovered by W. C. Roentgen in the year 1895 the rays that have been named for him".—*Fig. 2:* Wilhelm Konrad Roentgen, 1845-1923.

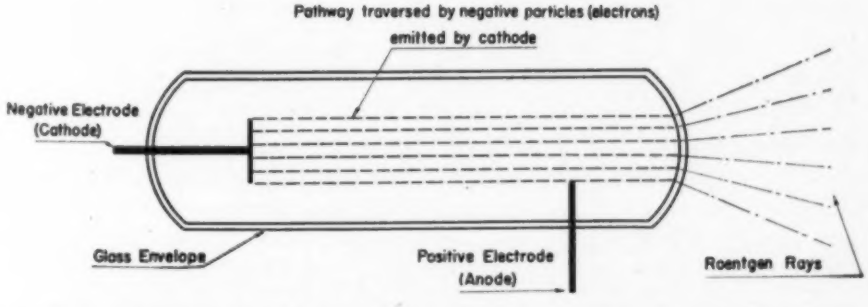

Fig. 3: Schematic diagram of Crookes' tube with which Roentgen was experimenting when he first detected the radiation which now bears his name.

within the tube was immediately ionized and this condition caused the ejection from the negative electrode of a stream of charged particles (electrons) which traveled in the direction of the positive electrode. Their momentum, however, carried them past this structure, and they impinged upon the glass end of the tube. The pathway along which these particles traveled is shown in dotted outline in Figure 3. The interaction of the electrons and the atoms comprising the glass wall of the tube produced the penetrating radiation which Roentgen detected by means of the barium platinocyanide screen.

In the half-century that has elapsed since 1895, the roentgen ray has found wide application in the fields of medicine and industry. This has been made possible by the refinement and progressive development of the original apparatus. First, in the early 1900's the rather unsatisfactory induction coil was replaced by the high-tension alternating current transformer. Soon after, rectification systems were added to permit the utilization of both phases of the alternating current wave. Lemp in 1897, Koch in 1904, and Snook in 1907[3] developed the once-popular motor-driven mechanical rectifier. Later on, Caldwell in 1910 and Dushman in 1915[3] perfected a valve tube rectifier which provided increased stability and noise-free operation of the roentgen ray unit (Figs. 4 and 5).

The early roentgen ray tubes were modifications of the Crookes' tube. They were characteristically erratic in performance, however, and it was, therefore, impossible to realize their full potentialities. This difficulty was brilliantly overcome in 1913 when Coolidge[4] perfected the hot-cathode roentgen tube. Until this time, the principal refinement in roentgen tube design was the electrostatic

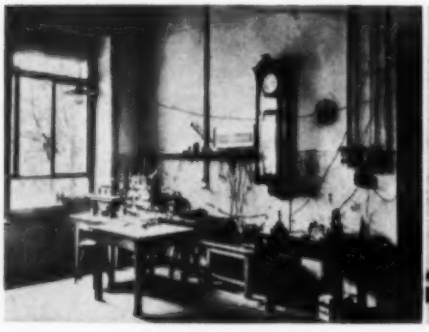

Figure 4

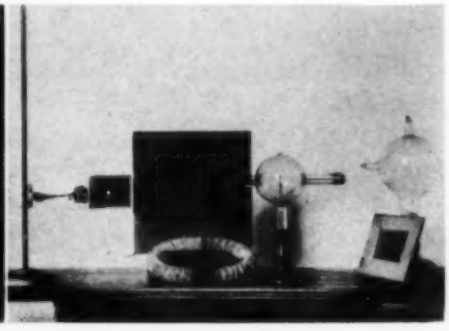

Figure 5

Fig. 4: Roentgen's laboratory. This photograph was made in 1923. The benches, the clock, and much of the apparatus that may be seen are as they were in Roentgen's days. The electric light and the power lines are modern additions.
Fig. 5: Collection of coils, screens, tubes and targets said to have been used by Roentgen.

focusing of the stream of particles (electrons) emitted from the tube's negative electrode on a tungsten target rather than on the glass walls of the tube. However, little control could be exercised over the intensity of this electron stream and, as a result, tube performance was exceedingly unreliable. The replacement of the cold cathode by a heated filament and the total evacuation of the tube permitted the establishment of full control over the cathode ray stream. In a completely evacuated tube equipped with a heated filamentary cathode, the cathode ray stream is composed of electrons "boiled" from the filament's surface. The intensity of the stream is dependent on the temperature of the filament and, accordingly, regulation of the cathode ray stream may be obtained by controlling the heat of the filament.

Since 1913 the principal roentgen tube developments are the shock-proof tube, the ray-proof tube, and the rotating anode tube. The first two developments have added greatly to the safe operation of roentgen apparatus. The third has improved the clarity of roentgenographic films by permitting the tube to be operated at high energies and with small target areas. Image unsharpness, formerly caused by long exposure times and large target areas, was thereafter greatly reduced.

From the inception of the roentgen ray both fluoroscopy and roentgenography were used to record roentgen images. In the former, screens of the barium platino-cyanide type were used but were soon found to be unstable and were replaced by calcium tungstate and zinc sulfide screens. Later, cadmium tungstate and zinc cadmium sulfide screens replaced the older materials.

In the early days, roentgenography was performed with standard photographic plates, a method which proved extremely inefficient. A considerable improvement was achieved soon after the beginning of the 20th century when the practice of exposing these plates with single fluorescent screens was introduced. Photographic emulsions in general are relatively insensitive when exposed to roentgen rays directly but their sensitivity may be markedly increased by exposing them to fluorescent light which has been incited by roentgen radiation.

Photographic plates were replaced by the more convenient roentgenographic film soon after the opening of the first World War, a change made mandatory by the critical supply problems of the Army. In 1919 the practice of coating both sides of the film with a photo-sensitive emulsion was begun. This was followed in the next year by the introduction of double-type intensifying screens with which both layers of the roentgenographic film receive exposure. By this means the sensitivity of the film was greatly increased. Until 1929 roentgenographic film was normally

supplied with the emulsion coated on a nitrate base. After the disastrous fire which occurred at the Cleveland Clinic, in that year, the non-inflammable cellulose acetate base was adopted universally (Figs. 6 and 7).

Through the years there have been many additional technical developments which have contributed to the use of the roentgen ray as a diagnostic medium. Of these, the Potter-Bucky[5] diaphragm is probably the most important. This device, a relatively simple mechanism which consists of alternate laminations of lead foil and wooden strips, effectively eliminates the major quantity of the scattered radiation which otherwise would reach the roentgenographic film. The removal of this scattered radiation is extremely important, because its presence fogs the roentgenographic film and markedly reduces its clarity. Another technical development which has enjoyed wide use is stereo-roentgenography by means of which three dimensional perception of the anatomical structure under examination is possible. A third development is planigraphy or body section radiography which first was described by Bocage[6] in 1921. This technique, however was not perfected until 1930, when it became a valuable diagnostic adjunct. Kymography, a technique by which various physiological motions may be recorded on the roentgenographic film, was introduced first

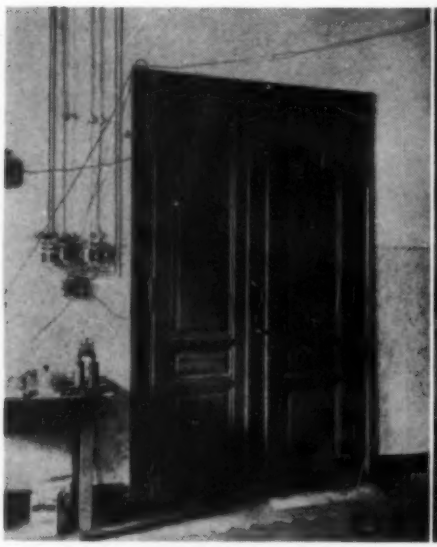

Figure 6

Figure 7

Fig. 6: Wooden doors between Roentgen's laboratory and an adjacent room through which Roentgen made one of his earliest plates. He found that the wood was transparent and that there were linear streaks which he identified as the shadows of white lead that had been used in setting the panels in the door frame.—*Fig. 7:* Desk used by Roentgen in his laboratory.

in 1911.[7] It was not until after 1928, however, that this procedure received widespread attention, and its use in the study of cardiac motion was delineated. The recently announced electrokymograph,[8] a photoelectric roentgen device by which physiological motion is recorded much more clearly than in previous kymographic procedures, will undoubtedly extend the usefulness of the method still further.

At an early date it was recognized that the roentgen ray characteristics of most anatomic tissues were such that they could not be visualized without the use of contrast media. In the case of the chest the accidental introduction of bismuth paste into the bronchial tree during gastro-intestinal examinations was the first instance in which a contrast medium was employed. This was soon followed by the deliberate installation of other bismuth compounds and then the less noxious iodized oil preparations.

Of considerable interest to the chest physician has been the development of photofluorography. This procedure, in which a fluorescent image of the chest is photographed on film of reduced size, was first developed by Bleyer in 1897.[9] The method, however, did not become practical until the early 1930's when it became widely used as a tuberculosis case-finding medium.

One of the most recent technical developments is the automatic photo-electric timing mechanism—the phototimer. The purpose of this device is to produce uniformity in the quality of roentgenographic films. It was first used in 1941[10] to control the exposure of gastro-intestinal roentgenograms. It has since earned a valuable place in mass radiography, and is at the present time being developed for use in general roentgenography.

In the foregoing paragraphs the discussion has been centered solely on the diagnostic applications of the roentgen ray. Developments in the field of therapeutic radiology, however, have followed along fundamentally similar lines, although the emphasis has been on the use of a much wider range of kilovoltages. It has been hoped to discover by this method a roentgen tube potential which will produce radiation having a specific lethal effect on neoplastic tissues. At the present time roentgen generators ranging in potential from 50 KVP to 1000 KVP are commercially available. Experimental generators (the betatron[11]) which have capacities up to 100,000 KVP have been produced. Indeed, a betatron having a capacity of 200,000 KVP and producing a roentgen beam of extremely high intensity (approximately 10 r at a distance of one or two kilometers) is said to have been contemplated by German scientists before the defeat of their nation. This instrument was to have been used, however, as a lethal military weapon rather than as a therapeutic device.

This leads us to speculate upon the course which further developments will take in the field of radiology. Almost certainly this course will be dictated by our needs, some of which already are clearly apparent. Mass radiography, for example, might be greatly facilitated if there were available a small compact roentgen generator weighing not more than 100 pounds that could be operated from domestic 110-volt power sources. Experiments which will lead, in the not too distant future, to the development of such a generator are in progress at the present time. The success of this research is dependent on accompanying developments in high tension cable design, on improvements in the speed of films and screens and on the simplification of roentgen machine controls. These developments will be applicable to a large number of other roentgenographic problems. At the present time the trend is toward the use of higher kilovoltages in roentgenography, but if potentials of 100 KVP are to be exceeded, present day cables sufficiently strong to withstand these voltages would be too bulky. There is reason to believe that before long relatively small cables able to withstand anticipated kilovoltages will be developed. They will be made possible by the use of new materials and new methods of fabrication.

In recent years there has been a tendency to simplify the operating controls of roentgen machines. Although not a great deal has been accomplished in this direction, it appears likely that with the further development of automatic exposure devices, single dial control panels are entirely feasible. With this one dial the technician would automatically select the proper kilovoltage, milliamperage, and exposure time for the anatomical structure under examination; indeed, it is conceivable that the dial might be labeled in terms of the part to be roentgenographed, such as chest, knee, skull, etc., rather than in numerical values of kilovoltage, milliamperage, exposure time, etc.

The value of roentgen cinematography has long been recognized. The procedure however, has not been feasible because present-day films and screens do not possess adequate speed and because present-day roentgen generators lack the efficiency needed for this operation. This situation may be expected to stimulate the development of faster screens and films. Furthermore, it probably will result in the production of roentgen-generating systems that utilize kilovoltages appreciably higher than those now in use in diagnostic roentgenographic equipment since the efficiency of generating systems rises sharply with increase in kilovoltage.

Considerable research will also be devoted to the development of entirely new roentgenologic methods. One of these, from which

almost unlimited possibilities may be forseen, is fluoroscopy to which has been added a system of amplification.[12] From the earliest days of roentgenology, fluoroscopy has remained at a stage analagous to that occupied by the crystal set in radio. The usefulness of this method has been seriously limited by the low visual acuity which an observer possesses when working at the low levels of illumination obtainable under existing fluoroscopic conditions. Accordingly, most roentgen procedures are conducted with roentgenography, even though this process introduces many technical and clinical disadvantages.

The limitations of fluoroscopy would be effectively overcome if fluorescent images could be amplified several thousand times. Then the illumination of the screen might be expected to approach the brightness of the usual roentgenographic view box. Visual acuity would be markedly increased and pathological processes could be visualized in multiple projections with the same clarity as that provided by a roentgenographic film. Furthermore, dark adaptation of the operator would no longer be required; indeed, examinations could be conducted in normally lighted rooms such as practitioners' offices, surgical amphitheatres, etc. The use of sufficient amplification would also allow considerable reduction in the intensity of the exposing radiation. Radiation hazards would be thereby largely eliminated. With fluorescent amplification, all roentgenographic procedures, including mass radiography, roentgen cinematography, kymography, etc., would be enormously simplified. If roentgenograms should be desired after a fluoroscopic examination, they could be secured by photographing the fluorescent screen. Thus powerful roentgen equipment would almost never be required, and the cost of the average installation would be markedly reduced.

Several means whereby fluorescent amplification may be accomplished have been proposed. One suggests the use of television methods; another the use of electron optics. At the present time the first of these appears to be entirely impracticable; the second, however, has very real potentialities and, doubtless, within the next few years a great many investigators will be engaged busily in exploring its possibilities.

How many of the foregoing speculations will achieve realization it is impossible to say. However, it will be interesting to follow the many developments which are almost certain to occur within the next few years. Until the present time roentgenology has constituted one of the most dynamic of the medical sciences. There is little reason to believe that it will ever be other than progressive and fruitful of significant achievements.

Acknowledgement

The original photographs reproduced in this paper are from the collection of Dr. Paul C. Hodges, Division of Roentgenology, the University of Chicago.

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The Segments of The Lungs

A Commentary on their Investigation and Morbid Radiology

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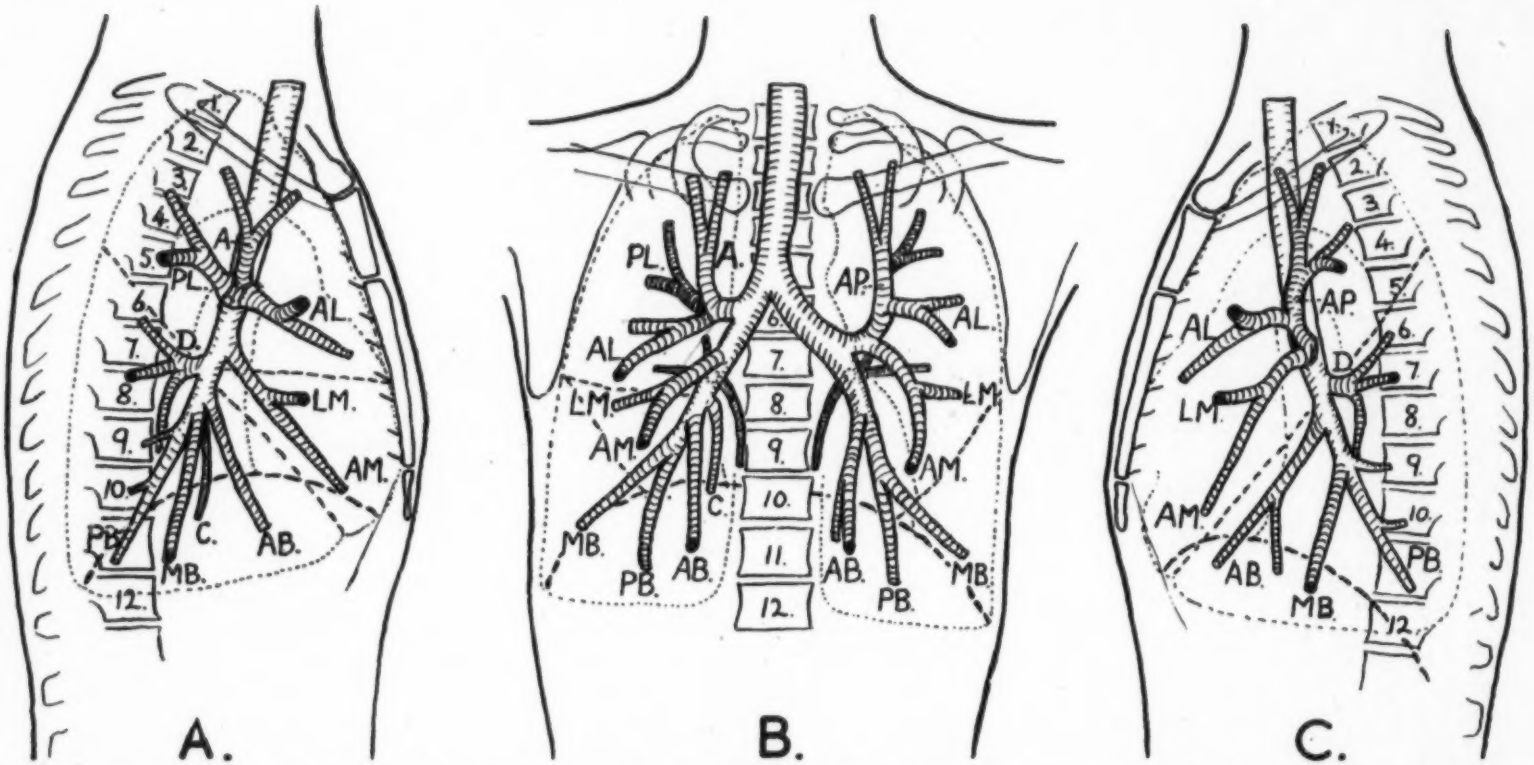

Fig. 1: The Bronchial Tree. (A): Right lateral view. (B): Anterior view. (C): Left lateral view.—A, Apical. AL, Anterolateral. PL, Posterolateral. LM, Lateral middle. AM, Anterior middle. D, Dorsal. PB, Posterior basic. MB, Middle basic. AB, Anterior basic. C, Cardiac.

HISTORICAL INTRODUCTION

It has been known for many years that each branch of the bronchial tree aerates a separate wedge of lung tissue. In 1889, William Ewart,[1] who was physician and pathologist at the Brompton Hospital, wrote of large groups of lobules in each lung, isolated from one another as regards their air supply and forming separate respiratory districts. Thus the credit must go to Ewart for being one of the first to describe the units which we now call broncho-pulmonary segments. This remarkable anatomist was far ahead of his age, but his descriptions of the structure of the bronchi and lungs were largely forgotten until recently, although both his methods of investigation and his discoveries have stood the test of time.

In 1932, Kramer and Glass[2] defined a broncho-pulmonary segment as an area of lung supplied by a constantly placed bronchus, having an orifice situated in a large lobar bronchus and visible to the bronchoscopist. Since then, other accounts of the bronchi and broncho-pulmonary segments have been published (Nelson,[3] Lucien and Weber,[4] Neil, Gilmour and Gwynne,[5] Behr and Huizinga,[6] Pierce and Stocking,[7] Adams and Davenport,[8] Foster-Carter,[9,10,11] Brock[12]), illustrated with diagrams showing the position of the segments on the surface of the lungs. At first sight these maps look very different, but this is largely because there has been no general agreement upon the bronchi selected for description. Some authors have confined themselves to charting areas supplied by large and relatively constant bronchi, while

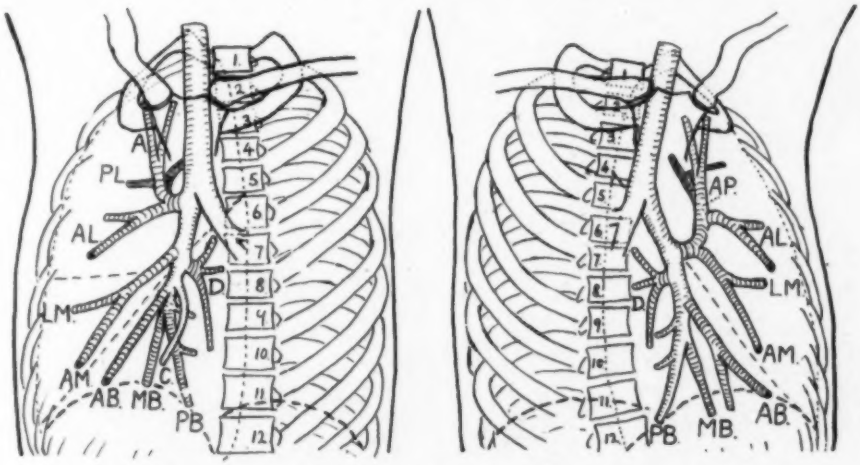

Fig. 1: The Bronchial Tree. (D): Left anterior oblique view. (E): Right anterior oblique view.—A, Apical, AL, Anterolateral. PL, Posterolateral. LM, Lateral middle. AM, Anterior middle. D, Dorsal. PB, Posterior basic. MB, Middle basic. AB, Anterior basic. C, Cardiac.

others have attempted to map out the segments served by smaller branches. The portrayal of broncho-pulmonary segments is thus bound to be arbitrary, for it is conditioned by the bronchi selected. Either a whole lobe or a terminal lobule may be regarded as a broncho-pulmonary segment, depending upon whether a lobar bronchus or a terminal bronchiole is the unit. But, allowing for some minor faults, all previous accounts really depict a common bronchial pattern (Fig. 1).

It therefore seems to us expedient to define a broncho-pulmonary segment as the portion of lung served by a principal branch of a lobar bronchus, and this branch may then be called a segmental bronchus. Such branches are large and relatively constant, and they are familiar already to those who have a knowledge of bronchial anatomy. Although there can be variety in the shape and size of the segments in different subjects, there is a characteristic pattern, which is common to all (Fig. 2). In this pattern, based upon the segmental bronchi as we have defined them, each lobe is divided conveniently into a few major districts. The smaller bronchi are less constant in their relative size and mode of branching than the larger ones and variations are more common, so that individual accounts of these subsegments will differ considerably. Further subdivision has a limited application to special problems, such as the localization of a lung abscess, but for gen-

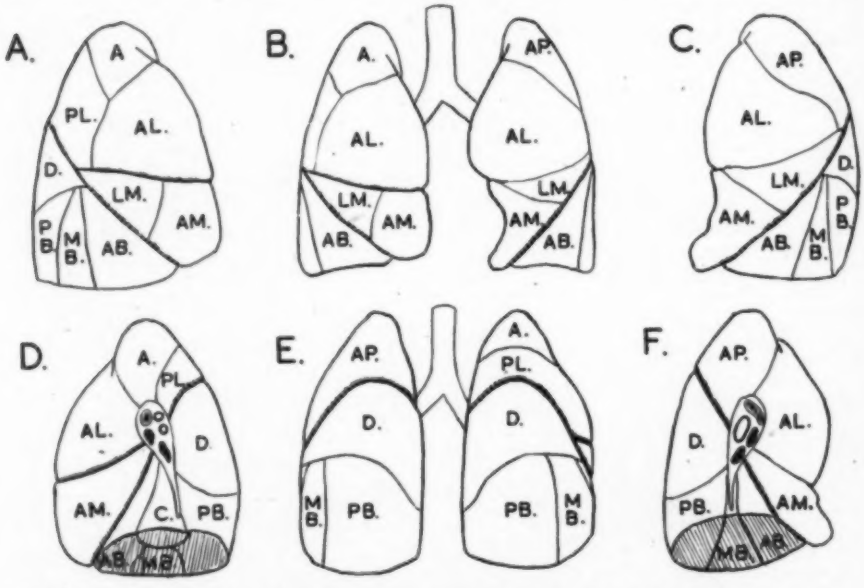

Fig. 2: The Broncho-Pulmonary Segments. (A): Right lung, lateral view. (B): Both lungs, anterior view. (C): Left lung, lateral view. (D): Right lung, medial view. (E): Both lungs, posterior view. (F): Left lung, medial view.—A, Apical. AL, Anterolateral. PL, Posterolateral. LM, Lateral middle. AM, Anterior middle. D, Dorsal. PB, Posterior basic. MB, Middle basic. AB, Anterior basic. C, Cardiac.

eral use it is confusing and we believe unprofitable. A point is soon reached when the branches hide the tree.

The objects of this paper are threefold; to describe the methods whereby the radiological anatomy of broncho-pulmonary segments has been investigated; to give an account of the broncho-pulmonary segments with special reference to the radiological features of segmental lesions; and to discuss the application of this knowledge to medical problems.

METHODS OF INVESTIGATION

The Anatomy of Normal Segments:

The respiratory districts of the lung may be studied in various ways. The anatomy of the bronchi themselves must first be learned from casts, dissections and bronchograms, and Figure 1 represents the most common arrangement of the more important bronchi (Foster-Carter[9,10,11]). The topography of the bronchial distribution may be learned both from the study of excised lungs and from radiographs of the living. The study of bronchial casts (Fig. 3) gives a rough idea of the distribution of the segmental bronchi, but the exact surface limits of an individual segment can be

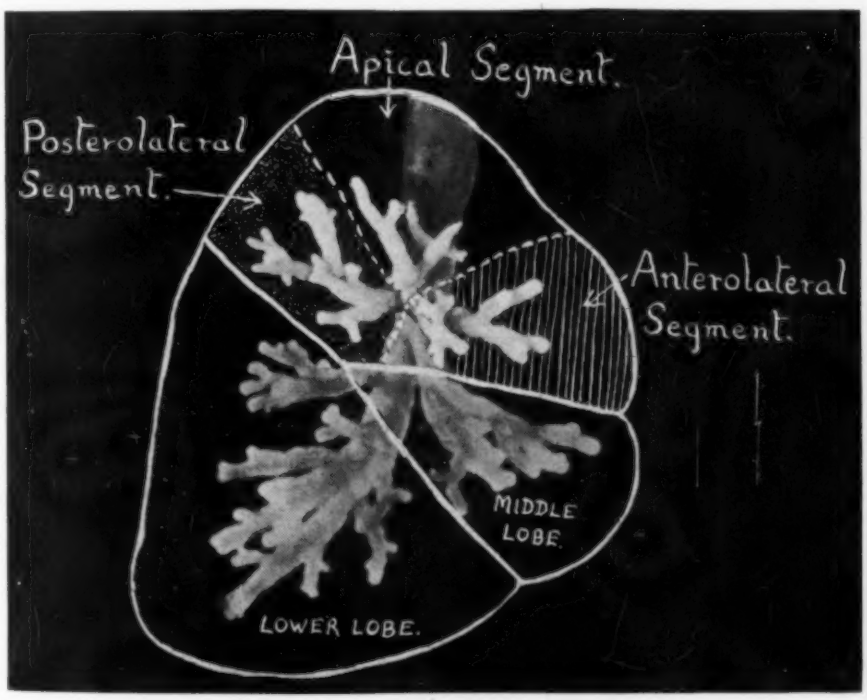

Fig. 3: Celloidin Cast of Right Bronchial Tree of 180 mm. Human Embryo; lateral view. Approximate positions of the lung and upper lobe segments have been outlined.

shown by distending it with air through its bronchus (Fig. 5a). This method of inflation is of great antiquity; it was used by Leonardo da Vinci (Hopstock[13]) and other ancient anatomists investigating the structure of the lungs. Celloidin, gelatin, parrafin wax and radio-opaque materials have been used in the same way to make more permanent preparations. The most complete picture of both the external and internal configuration of a broncho-pulmonary segment is obtained by injecting it with gelatin or wax and then making serial slices through the lung, from which the segment may be reconstructed (Fig. 5b).

The Anatomy of Segmental Lesions:

When the normal anatomy of the broncho-pulmonary segments has been determined by these methods, it becomes clear that many pulmonary opacities seen in radiographs of patients conform in shape, size and position to broncho-pulmonary segments. Further evidence that such opacities are segmental is sometimes provided by finding a lesion in the segmental bronchus. Additional proof of the segmental nature of these radiological shadows was sought from scale models of the lungs, constructed in plasticene. These were divided into lobes and segments. The positions of the lobar and inter-segmental boundaries were determined by taking the average or most common arrangement found in the anatomical studies (Figs. 2 and 4). Plasticene is a substance which, like consolidated lung, is only partially opaque to x-rays; and consequently

Fig. 4: Plasticene Model of Right Lung; lateral view.

a radiograph of an irregular piece of plasticene shows a variation in density proportionate to the thickness of the mass in the path of the rays. The next step was to place each plasticene segment in the position which it would normally occupy in the body and to take both postero-anterior and lateral radiographs of it. As

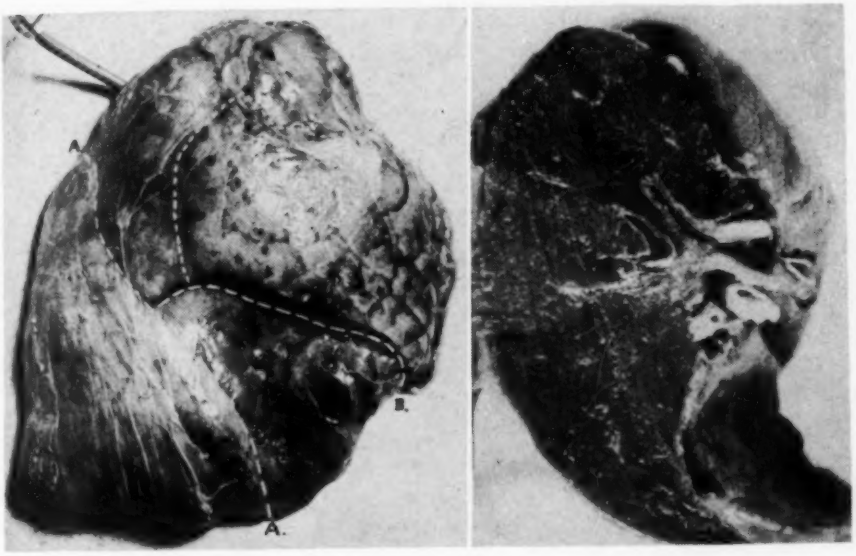

Figure 5a *Figure 5b*

Anterolateral Segment of Right Upper Lobe. *Fig. 5a:* Right lung, anterolateral segment inflated with air; A, greater fissure, B, lesser fissure.—*Fig. 5b:* Horizontal section through right upper lobe, from above; segments injected with coloured gelatin; anterolateral, light, posterolateral, dark.

Figure 5c *Figure 5d*

Anterolateral Segment of Right Upper Lobe. *Fig. 5c:* Plasticene model of anterolateral segment, anterior view.—*Fig. 5d:* Lateral view of same model.

these represented the radiological appearance of a solid copy of this area of the lung, a consolidation of the corresponding segment in the living subject would be expected to cast a similar shadow. In every case the radiographic shadows of the model segments proved to be closely similar to those which were thought to be segmental consolidations in the lungs of living subjects.

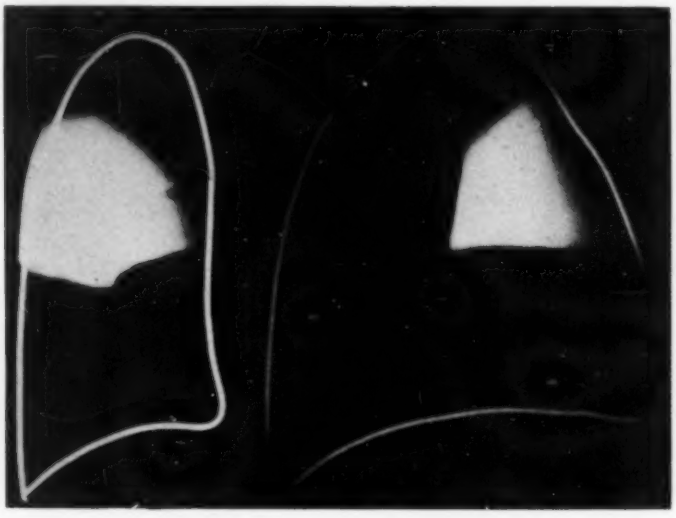

Figure 5e *Figure 5f*

Anterolateral Segment of Right Upper Lobe. *Fig. 5e:* Radiograph of C.—*Fig. 5f: Radiograph of D.*

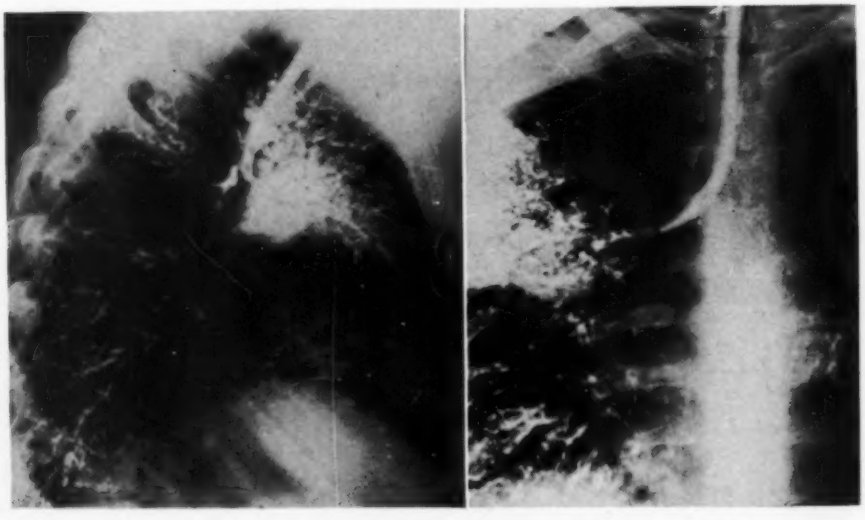

Figure 5g *Figure 5h*

Anterolateral Segment of Right Upper Lobe. *Fig. 5g:* Postero-anterior radiograph of patient showing anterolateral segment outlined with iodised oil.—*Fig. 5h:* Lateral radiograph of same patient.

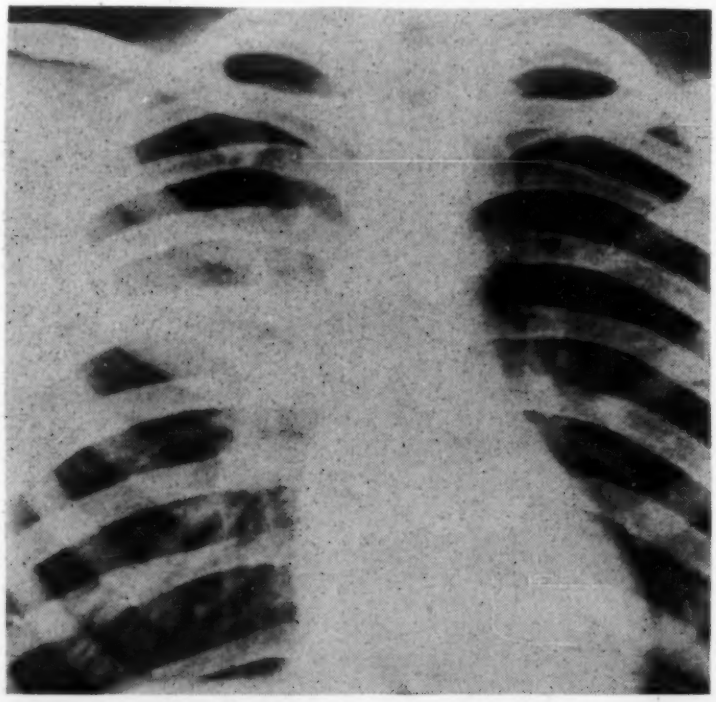

Figure 5i

Anterolateral Segment of Right Upper Lobe. Postero-anterior radiograph showing consolidation of anterolateral segment due to a lung abscess; confirmed by bronchography. Raising of fissure indicates some associated collapse.

Figure 5j

Anterolateral Segment of Right Upper Lobe. Lateral radiograph of same patient.

The variations in density within the consolidated segments due to their shape, matched those seen in the radiographs of the models (Figs. 5a to 5j).

Pathological material often provides proof of the anatomical and functional independence of the broncho-pulmonary segments in the human lung. A segment may be outlined by infection or collapse in sharp distinction to its relatively normal neighbors (Figs. 6a, 6b and 6c). When infection is present, the fibrous septa between the segments are often thickened and can be seen in microscopic preparations (Fig. 6d) or even with the naked eye (Fig. 6c). These septa are formed by the inter-lobular septa described by Miller.[14] They rarely present a complete plane surface because, here and there, groups of lobules of adjoining segments interdigitate, but for convenience they may be represented in diagrams as smooth lines and this is sufficiently accurate for most purposes. The inter-segmental boundaries are also often

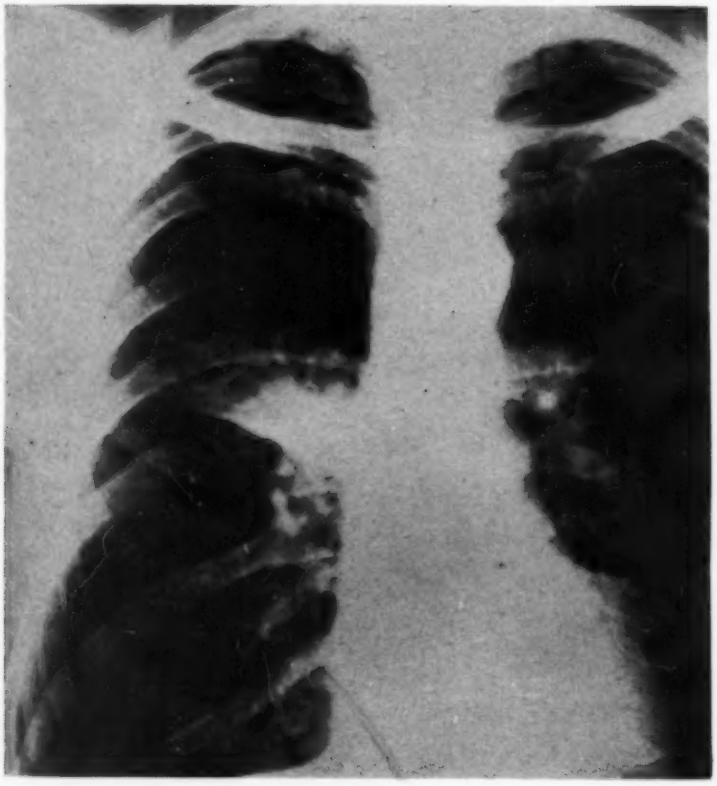

Figure 6a

Collapse of Anterolateral and Posterolateral Segments of Right Upper Lobe. Postero-anterior radiograph of patient with carcinoma of eparterial bronchus obstructing anterolateral and posterolateral branches, showing para-hilar opacity.

marked by partial fissures on the surface of the normal lung (Fig. 7) and cases of this type have sometimes been described as supernumerary lobes.

In our description, we have chosen to represent the radiological features of consolidation and collapse of each segment. Such an account is bound to be idealistic, since true consolidation and true collapse are comparatively rare. In practice, most segmental lesions are due to a mixture of these two processes, and it is only possible to say from a radiograph that one or other element predominates. In nearly all so-called segmental consolidations, the radiographic shadow is smaller than would be expected from anatomical studies and models of inflation preparations, owing to associated collapse. Further evidence of this admixture of collapse with consolidation is often provided by: I, Emphysema of

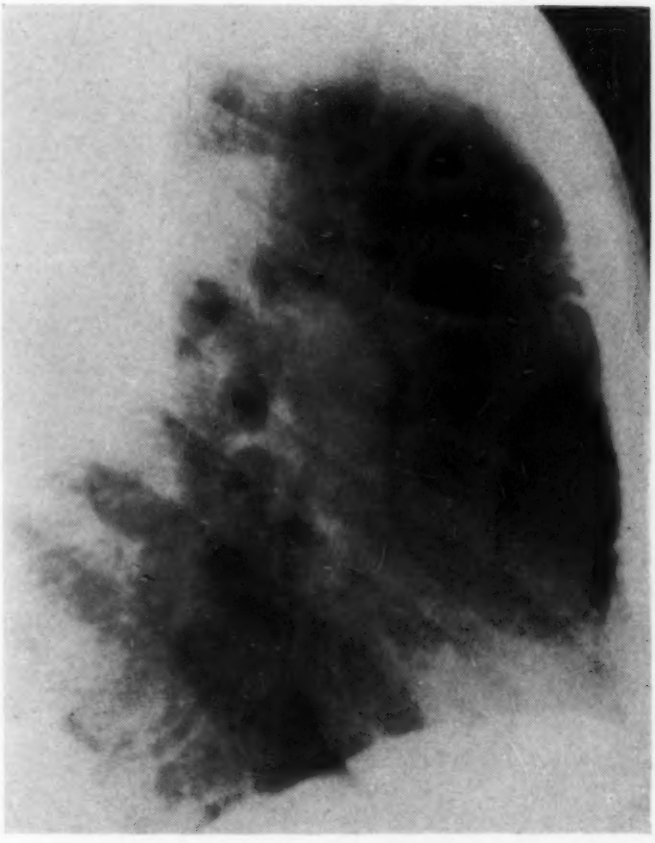

Figure 6b

Collapse of Anterolateral and Posterolateral Segments of Right Upper Lobe. Lateral radiograph of same patient showing narrow shadow of collapsed anterolateral segment along line of lesser fissure and shadow of collapsed posterolateral segment superimposed on aorta.

an adjoining segment. II, Curving of an interlobar fissure towards the shadow. III, Compensatory displacement of the mediastinum or diaphragm. Conversely, there is nearly always some consolidation in a collapsed segment (Figs. 6c and 6d). Also, the size of each broncho-pulmonary segment, relative to its neighbors, varies somewhat in different individuals. But a knowledge of the basic pattern of the bronchi and segments, and of their radiological features in consolidation and collapse, will help the observer to recognize and identify the majority of segmental lesions.

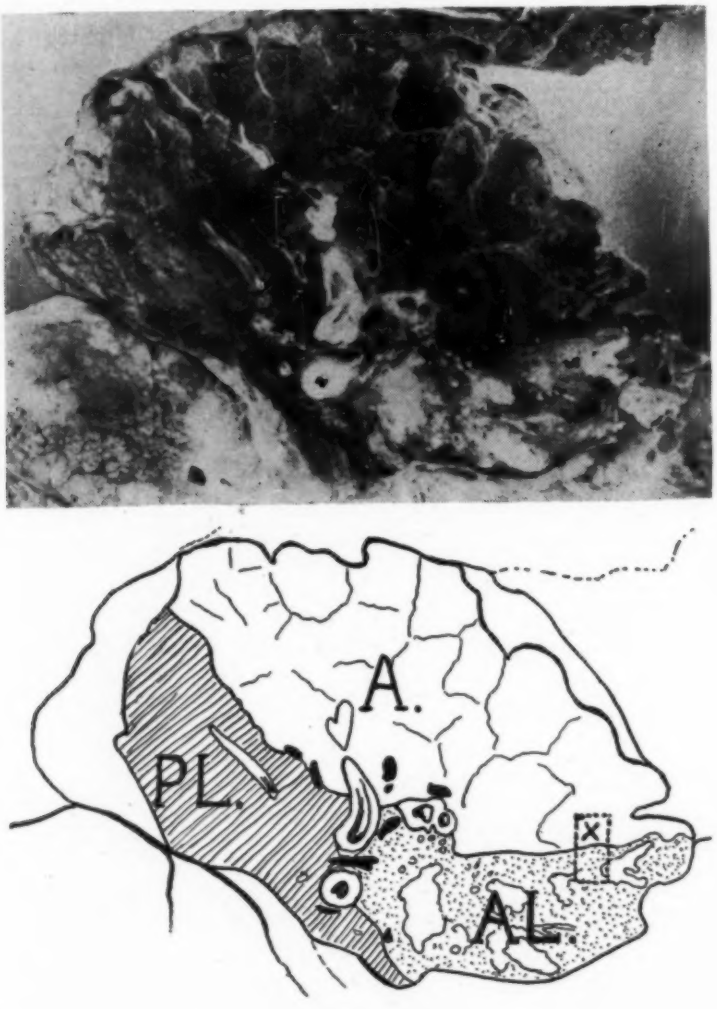

Figure 6c

Collapse of Anterolateral and Posterolateral Segments of Right Upper Lobe. Vertical section through right upper lobe of same patient, lateral view; AL, collapsed and infected anterolateral segment. PL, partially collapsed posterolateral segment. A, emphysematous apical segment.

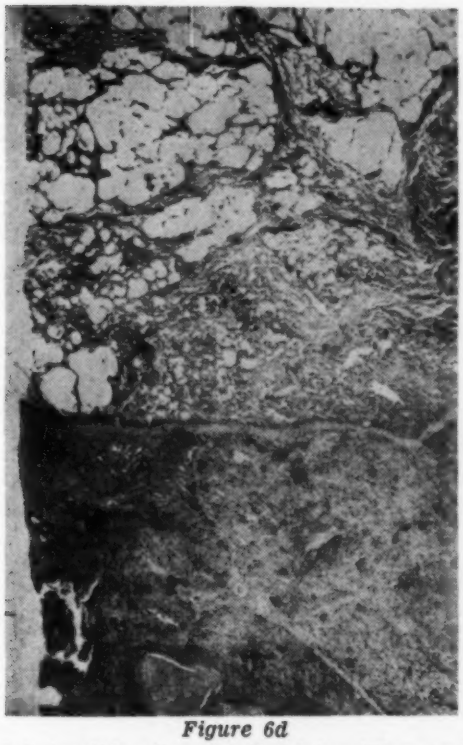

Figure 6d

Collapse of Anterolateral and Posterolateral Segments of Right Upper Lobe. Photomicrograph of section from area marked "X" in C, showing thickened inter-segmental fissure separating emphysematous apical segment, above, from infected and collapsed anterolateral segment, below. (Lung removed by operation.)

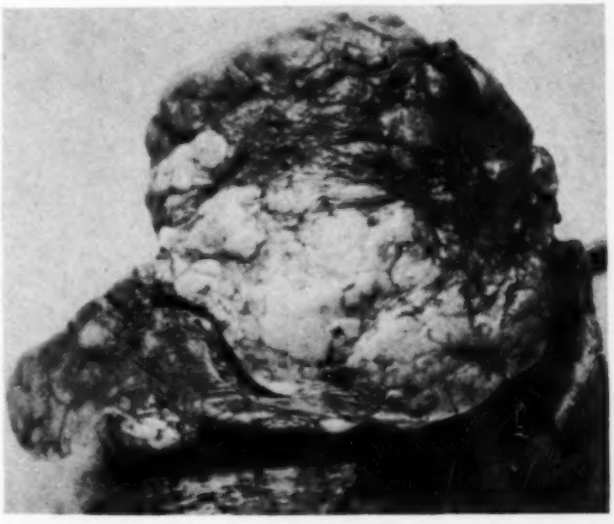

Fig. 7: Additional Fissure Between Anterior and Lateral Segments of Lingula. Left upper lobe, lateral view; lateral middle segment distended with air, remainder of lobe smaller than normal owing to fibroid tuberculosis.

THE RADIOLOGICAL FEATURES OF SEGMENTAL LESIONS

There are nine major segments in the right lung and eight in the left lung. Figures 1, 2 and 8a to 8f illustrate the bronchi, the broncho-pulmonary segments and their surface anatomy. A dis-

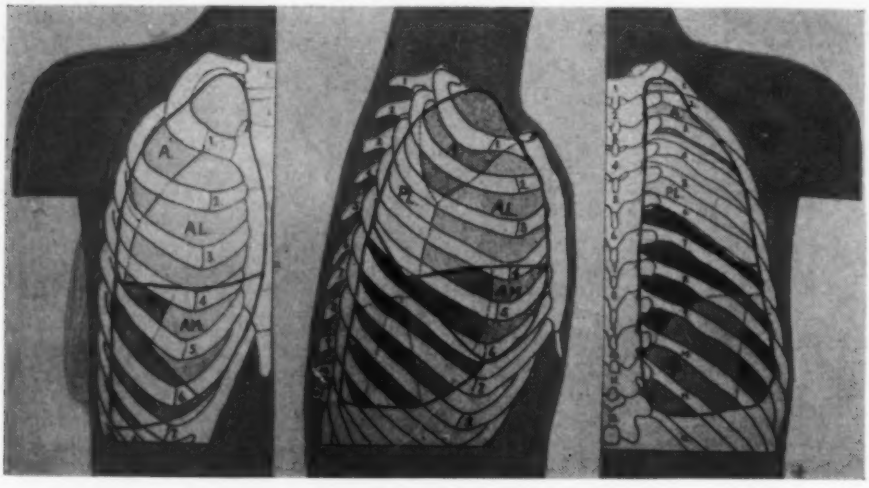

Figure 8a *Figure 8b* *Figure 8c*

The Broncho-Pulmonary Segments in Relation to the Chest Wall. *Fig. 8a:* Right lung, anterior view.—*Fig. 8b:* Right lung, lateral view.— *Fig. 8c:* Right lung, posterior view. A, Apical. AL, Anterolateral. PL, Posterolateral. LM, Lateral middle. AM, Anterior middle. D, Dorsal. PB, Posterior basic. MB, Middle basic. AB, Anterior basic.

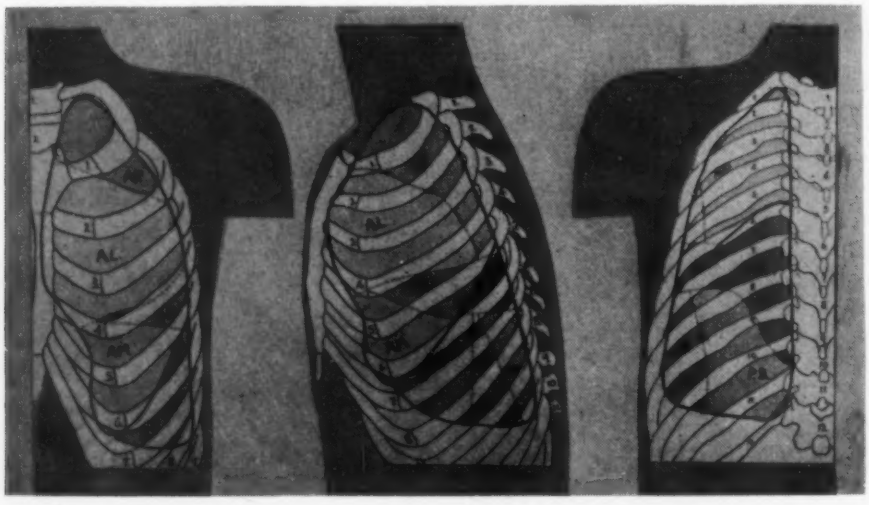

Figure 8d *Figure 8e* *Figure 8f*

The Broncho-Pulmonary Segments in Relation to the Chest Wall. *Fig. 8d:* Left lung, anterior view.—*Fig. 8e:* Left lung, lateral view.—*Fig. 8f:* Left lung, posterior view. A, Apical. AL, Anterolateral. PL, Posterolateral. LM, Lateral middle. AM, Anterior middle. D, Dorsal. PB, Posterior basic. MB, Middle basic. AB, Anterior basic.

eased segment is recognized radiographically both by its shape and by its position in relation to the thoracic cage and to the fissures of the lungs. The upper level of the oblique interlobar fissure on each side is commonly placed too high in text-book descriptions. It usually reaches only to the level of the neck of the 5th or 6th rib and is commonly somewhat higher on the left than on the right (Koch and Wieck,[15] Brock[16]). The levels of segmental boundaries described throughout this paper are given with reference to a standard centering of the x-ray tube on the 3rd costal cartilage at five feet distance.

Right Upper Lobe:

The lobe has three major segments, corresponding to the three divisions of the eparterial bronchus.

(1) *Right Anterolateral Segment:* Consolidation of this segment appears in the *postero-anterior* radiograph as a dense, homogeneous opacity, roughly quadrilateral in shape, extending from

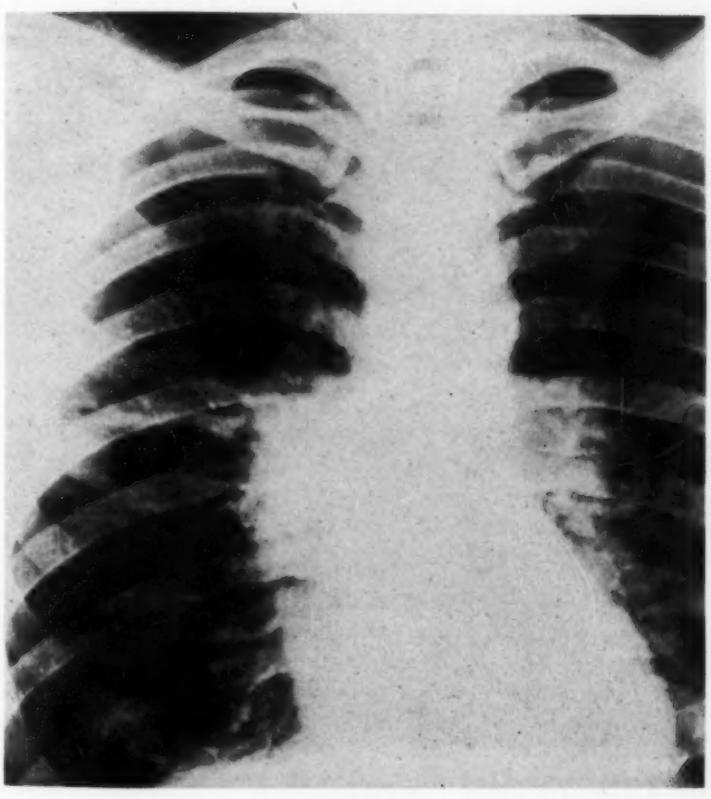

Figure 9a

Collapse of Right Anterolateral Segment. Postero-anterior radiograph showing para-mediastinal shadow at inner end of lesser fissure.

the hilum to the periphery (Fig. 5i). The lower border is limited by the lesser fissure and appears as a sharp horizontal line at about the level of the 4th costal cartilage. When there is associated collapse the fissure is often drawn up and the border then runs upwards and outwards. The upper limit of the shadow is variable; it is usually convex and slopes from the hilum upwards and outwards to reach the periphery at about the second rib. In the *lateral* radiograph, consolidation of this segment shows as a dense opacity above the lesser fissure, shaped rather like a wedge pointing towards the hilum (Fig. 5j). The lower border, formed by the fissure, is sharp and is directed horizontally or slightly downwards and forwards. The shadow extends back as far as the mid-axillary line and it is most dense in this region. There is usually a short, vertical posterior margin, merging above into the upper border which slopes upwards and forwards to the

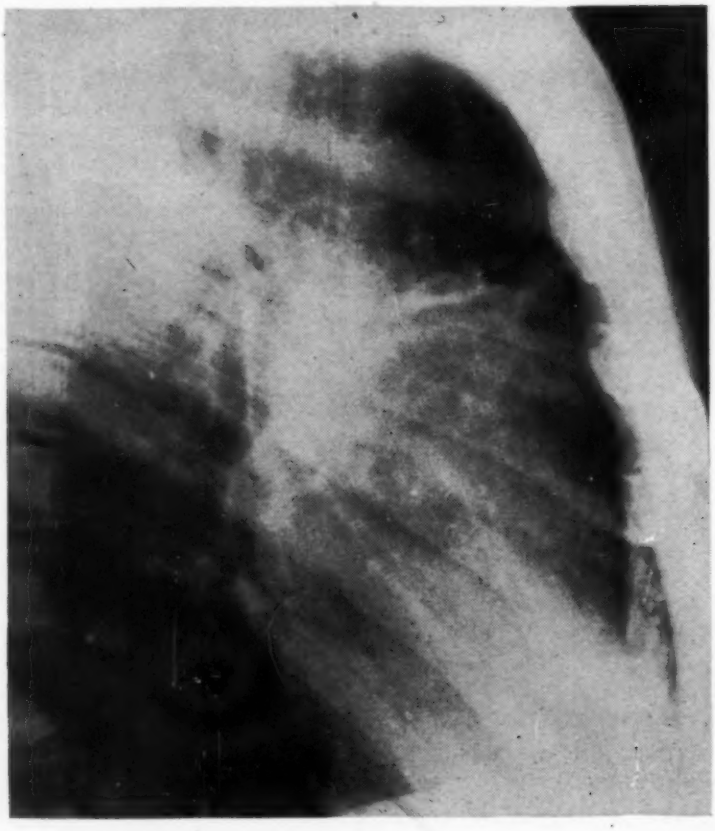

Figure 9b

Collapse of Right Anterolateral Segment. Lateral radiograph of same patient showing band-like shadow along line of lesser fissure. Patient had a malignant stenosis of anterolateral bronchus; confirmed by bronchography and bronchoscopy.

1st costal cartilage. The shadow decreases in density from behind forward, because the lateral depth of the segment is very small anteriorly (Figs. 5h and 5j). This is well seen in sections of the injected right upper lobe (Fig. 5b). The density distribution is shown also in radiographs of the plasticene model of this segment (Fig. 5f).

Collapse of the anterolateral segment of the right upper lobe reduces its size until, when completely collapsed, it may resemble an interlobar pleurisy. In the postero-anterior view there is a small para-hilar opacity at the inner end of the lesser fissure; while in the lateral view there is a narrow, band-like shadow above the fissure (Figs. 9a and 9b).

(2) *Right Posterolateral Segment:* Consolidation of this segment has a very similar appearance in the *postero-anterior* radiograph to consolidation of the anterolateral segment (Figs. 10a and 10c), but the shadow is usually smaller, distinctly quadrilateral, less homogeneous and has a less sharply defined lower border, also there is often a clear area between the inner border of the shadow and the mediastinum. The medial border extends upwards and a little outwards from the hilum to about the 2nd interspace anteriorly when it curves outwards to form the upper border, reaching the chest wall at the level of the 1st rib. The lower

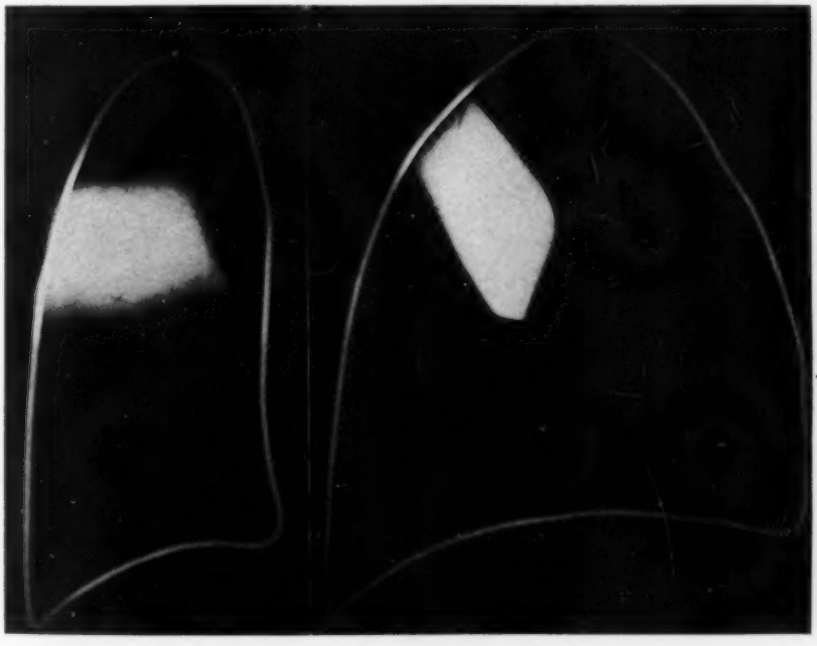

Figure 10a *Figure 10b*

Consolidation of Posterolateral Segment of Right Upper Lobe. *Fig. 10a:* Postero-anterior radiograph of plasticene model.—*Fig. 10b:* Lateral radiograph of model.

border runs from the hilum horizontally or slightly upwards and outwards, at the level of the 3rd or 4th costal cartilage. The maximum density of the shadow is peripheral and it fades markedly towards the hilum. In the *lateral* view (Figs. 10b and 10d). the shadow is situated posteriorly, is homogeneous and roughly quadrilateral in shape; the lower border, formed by the greatest fissure, is clear cut and slopes upwards and backwards from the hilum to reach the level of the 6th thoracic vertebra. If the segment extends forwards, as it commonly does, to about on the lesser fissure, the lower border turns horizontally forwards for a short distance at its anterior end (Fig. 10d). The anterior border extends vertically upwards in the mid-axillary region and merges into the upper border, which is directed upwards and backwards to gain the level of the 2nd or 3rd thoracic vertebra.

Complete collapse of the posterolateral segment gives a very

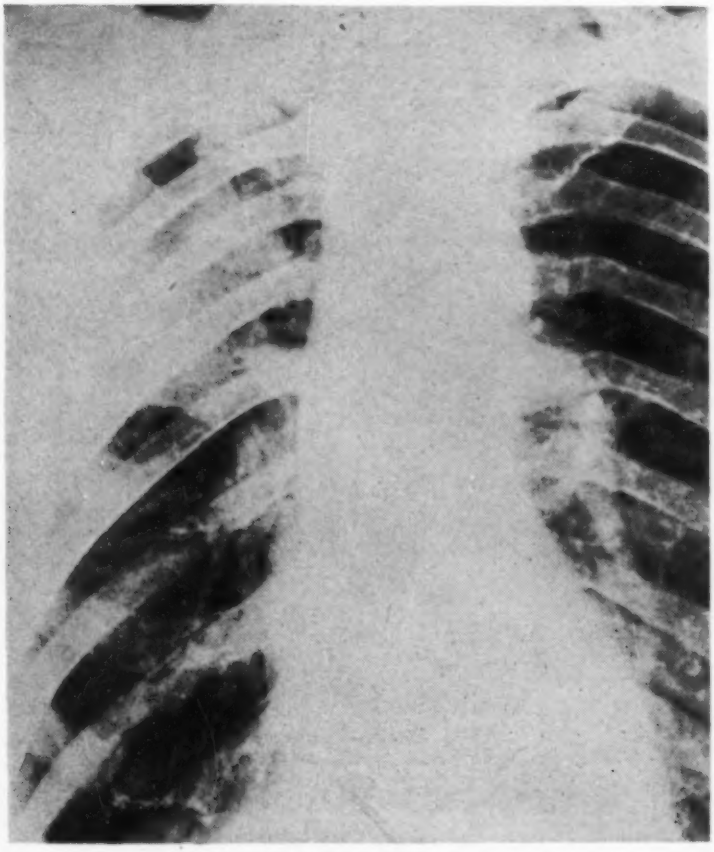

Figure 10c

Consolidation of Posterolateral Segment of Right Upper Lobe. Postero-anterior radiograph showing consolidation of posterolateral segment due to chronic suppuration; raising of fissure indicates element of collapse.

indefinite shadow in the postero-anterior radiograph (Fig. 11a), but in the lateral view the shadow is linear and again may be mistaken for thickening of the interlobar fissure (Fig. 11b). Various degrees of partial collapse may be seen (Figs. 12a and 12b). Collapse of the posterolateral and of the anterolateral segment, when seen in the lateral view, may be likened to the closing of a fan, the pivot being at the hilum (Figs. 6a, 6b and 6c).

Consolidation of these segments, adjacent to the interlobar fissures, may also be confused with an interlobar effusion and the radiographic appearances of the two conditions are similar except that an interlobar effusion is uniformly dense and fusiform in shape. Bronchography will usually distinguish for certain between them.

(3) *Right Apical Segment:* When this segment is consolidated, its shadow in the *postero-anterior* radiograph occupies an area bounded above by the dome of the pleura and on the medial side

Figure 10d

Consolidation of Posterolateral Segment of Right Upper Lobe. Lateral bronchogram of same patient showing obstruction of posterolateral bronchus in consolidated segment; confirmed at autopsy.

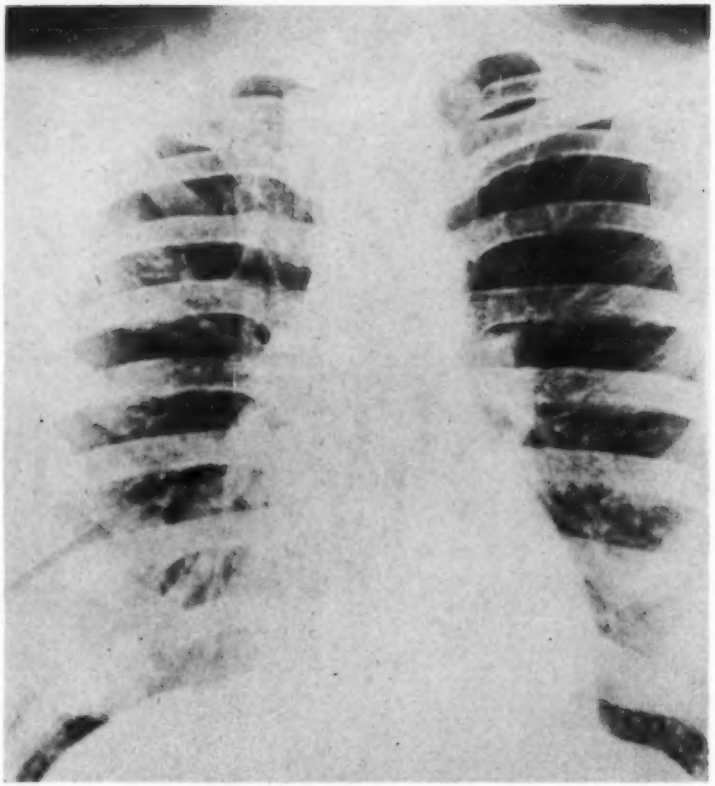

Figure 11a

Complete Collapse of Posterolateral Segment of Right Upper Lobe. Postero-anterior radiograph showing indefinite shadow at right apex.

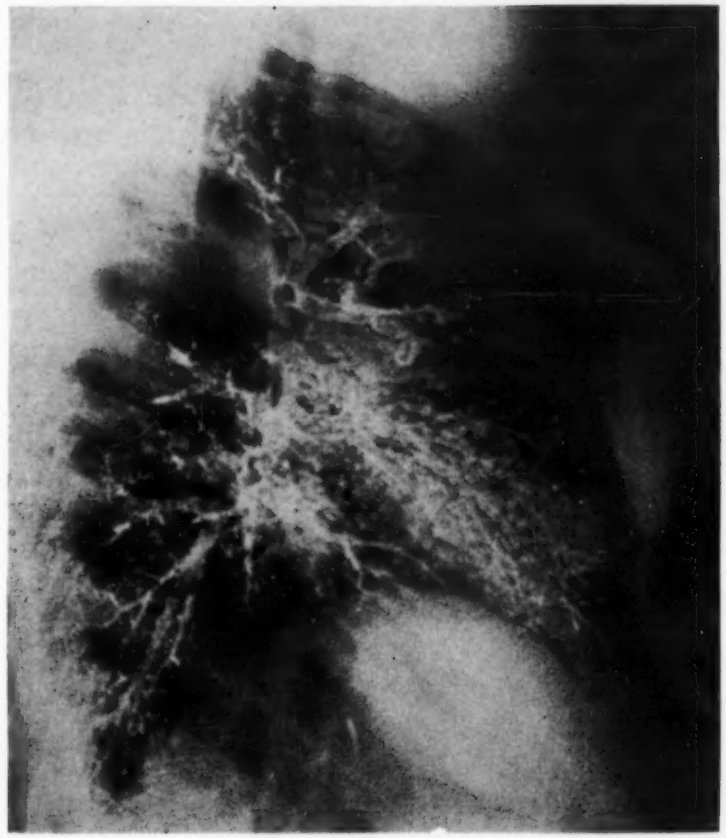

Figure 10b

Complete Collapse of Posterolateral Segment of Right Upper Lobe. Lateral bronchogram of same patient showing absence of posterolateral branch and linear shadow of collapsed segment. Patient had a tuberculous stricture of posterolateral bronchus; confirmed by lobectomy.

by the mediastinum (Fig. 13a). The lateral border is concave outwards and extends from the hilum at the level of the 3rd interspace anteriorly upwards and outwards to reach the periphery at the level of the 1st or 2nd rib. In the *lateral* radiograph (Fig. 13b) the opacity extends downwards in a V shape from the apex to the hilum and is often difficult to see because of the superimposed shadows of the shoulder.

When this segment collapses it usually shrinks inwards towards the mediastinum and may only be apparent as a slight widening of the superior mediastinum in the postero-anterior view (Fig. 14).

Minor Subdivisions of the Right Upper Lobe Segments (Fig. 15a):

The anterolateral division of the eparterial bronchus divides into two branches, anterior and lateral, and the subsegments supplied by these

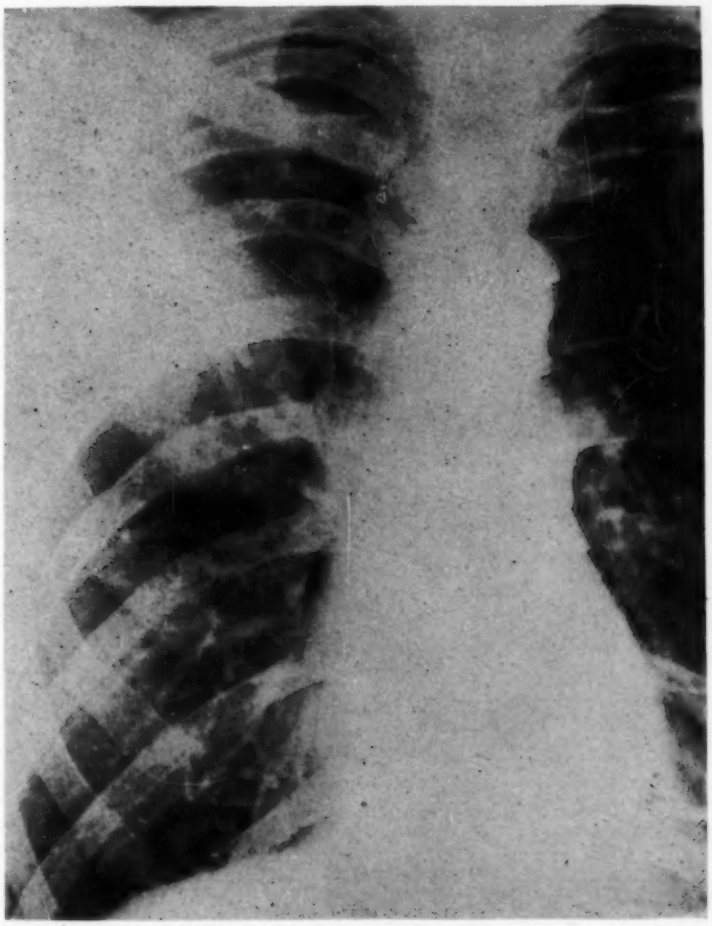

Figure 12a
Partial Collapse of Posterolateral Segment of Right Upper Lobe. Postero-anterior radiograph.

branches are sometimes involved separately in a pathological process. Similarly the posterolateral has two branches, posterior and lateral, while the apical division has two, anterior and posterior. These small subdivisions chiefly concern the surgeon; for instance the surgical approach to an abscess differs with the subsegment in which the abscess is situated. The lateral subsegments of the anterolateral and posterolateral divisions are not uncommonly the site of aspiration infections, either separately or together with an adjoining segment. Then, bronchography is often the only investigation which will show just how much of the lobe is involved.

Right Middle Lobe:

This lobe has two segments, corresponding to the two major divisions of its bronchus.

(1) *Right Anterior Middle Segment:* Consolidation of this segment appears in the *postero-anterior* view as a dense, roughly

Figure 12b

Partial Collapse of Posterolateral Segment of Right Upper Lobe. Lateral bronchogram of same patient showing obstruction of posterolateral bronchus due to carcinoma; confirmed by pneumonectomy.

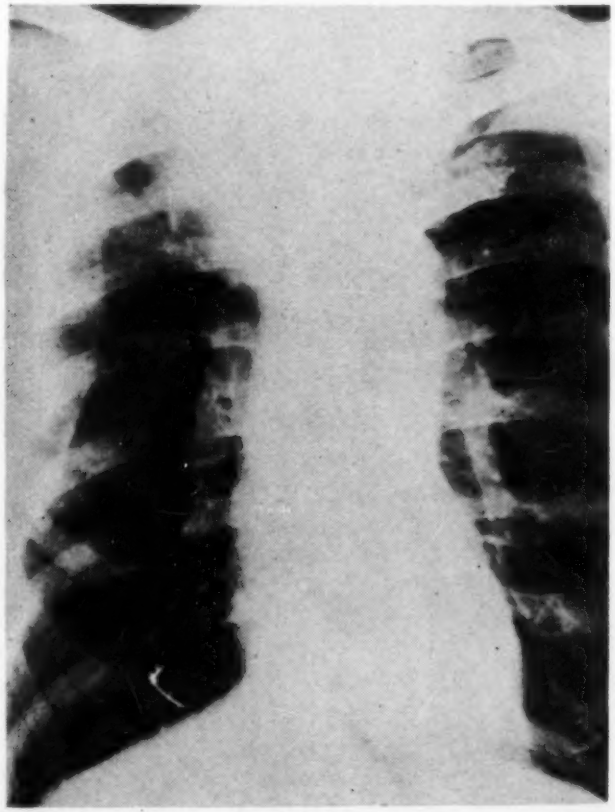

Figure 13a

Consolidation of Apical Segment of Right Upper Lobe. Postero-anterior radiograph of consolidation of apical segment due to malignant obstruction of apical bronchus; confirmed by bronchography.

Figure 13b

Consolidation of Apical Segment of Right Upper Lobe. Lateral radiograph of consolidated apical segment due to primary tuberculosis; concave margins of shadow indicate associated collapse.

quadrangular opacity extending out into the lung field from the right border of the heart (Figs. 16a and 16c). Its upper margin lies at about the level of the 4th costal cartilage, and the lower border usually overlaps the diaphragm. The shadow extends about halfway across the lung field in this view. In the *lateral* radiograph the shadow is triangular with its apex at the hilum and its base overlapping the lower end of the sternum and cartilages from the 4th costal cartilage to the diaphragm (Figs. 16b and 16d). The upper and lower borders are formed by the lesser and greater fissures and tend to be sharply outlined. The anterior half of the shadow is very dense, but towards the hilum the density decreases rapidly owing to the pyramidal shape of the segment.

(2) *Right Lateral Middle Segment:* In the *postero-anterior*

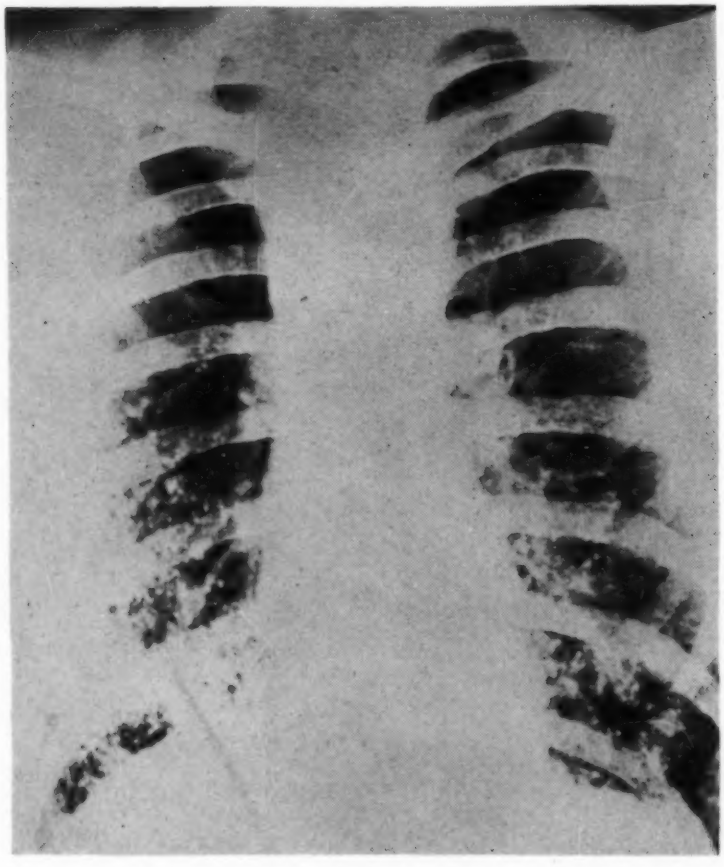

Figure 14

Collapse of Apical Segment of Right Upper Lobe. Postero-anterior radiograph showing widening of superior mediastinal shadow due to collapsed apical segment. Aetiology undetermined, confirmed by bronchography. Basal mottling due to residual iodized oil.

radiograph, consolidation of this segment appears as a dense shadow in the right middle zone (Figs. 17a and 17c). It is usually triangular with its apex pointing downwards. Its upper margin, formed by the lesser fissure, extends horizontally across the lung field at the level of the 3rd interspace anteriorly and is usually clear cut, because, in this view, the rays pass lenghtways along the fissure. The remainder of the opacity has ill defined borders and fades away below at the level of the 5th rib anteriorly. In

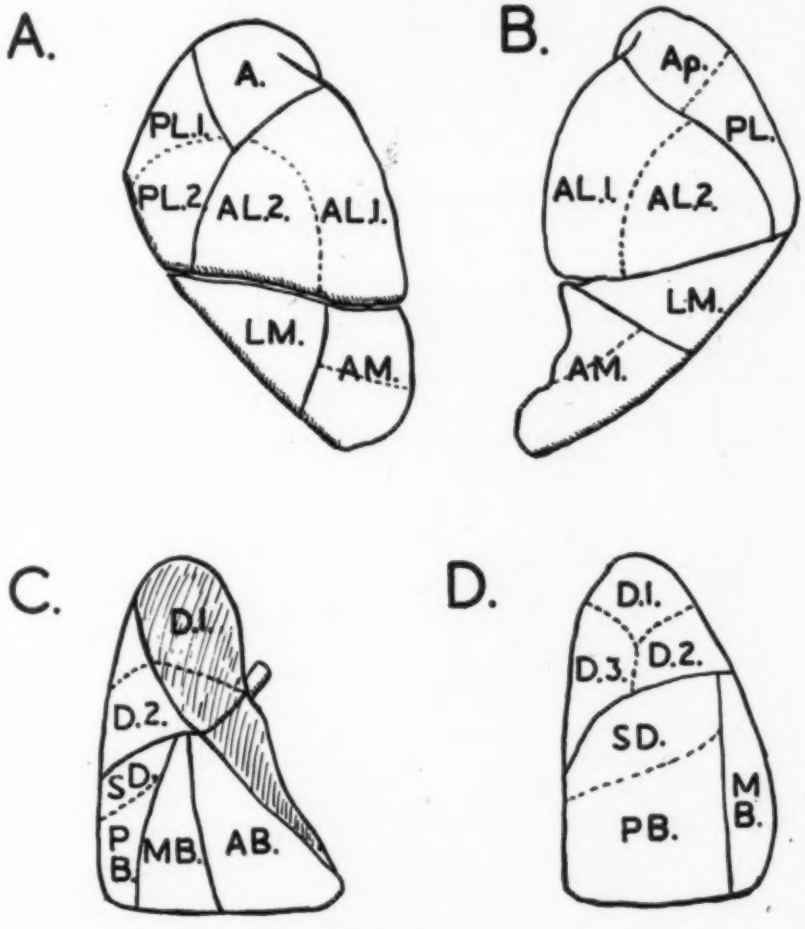

Figure 15

Minor Subdivisions of the Broncho-Pulmonary Segments. (A): Right upper and middle lobes, lateral view. (B): Left upper lobe, lateral view. (C): Right lower lobe, lateral view. (D): Right lower lobe, posterior view. AL.1, Anterior part of anterolateral segment. AL.2, Lateral part of anterolateral segment. PL.1, Posterior part of posterolateral segment. PL.2, Lateral part of posterolateral segment. A, Apical segment. Ap, Apical part of apicoposterior segment. PL, Posterolateral part of apicoposterior segment. D.1, Apical part of dorsal segment. D.2, Lateral part of dorsal segment. D.3, Medial part of dorsal segment. SD, Subdorsal part of posterior basic segment. PB, Remainder of posterior basic segment. MB, Middle basic segment. AB, Anterior basic segment.

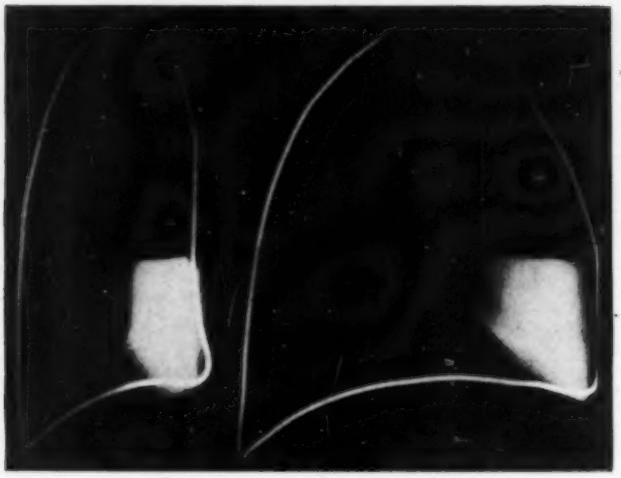

Figure 16a *Figure 16b*
Consolidation of Anterior Segment of Right Middle Lobe.
Fig. 16a: Postero-anterior radiograph of plasticene model.—
Fig. 16b: Lateral radiograph of model.

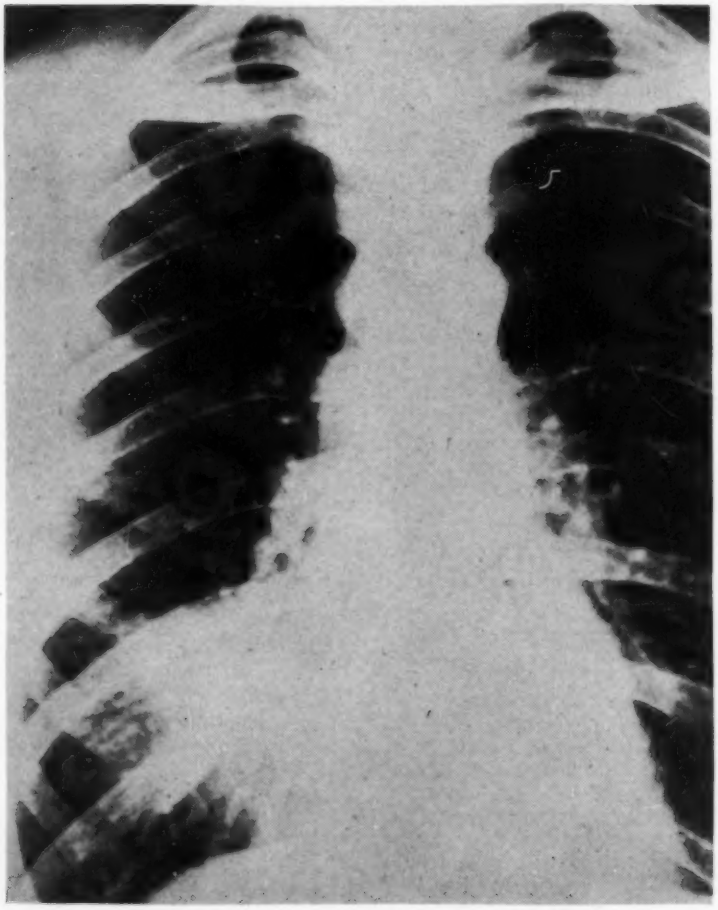

Figure 16c
Consolidation of Anterior Segment of Right Middle Lobe. Postero-anterior radiograph showing consolidation of right anterior middle segment due to benign, transient pneumonia.

the *lateral* view there is a dense triangular opacity extending forwards and downwards from the hilum and bounded above and below by the lesser and greater fissures (Figs. 17b and 17d). The shadow has a strikingly straight vertical or slightly inclined anterior margin which marks the division between the two middle lobe segments.

Segmental collapse in the right middle lobe is uncommon, although collapse of the whole lobe is often seen. Perhaps this is because the right middle bronchus is a long, narrow tube and obstructing agents, such as thick mucus, tend to be arrested in the bronchus itself before reaching its divisions. Hilar adenitis also obstructs the middle bronchus itself rather than an individual branch because of the length of this bronchus before it divides; this also places the orifices of the segmental bronchi beyond the view of the bronchoscopist.

A segmental consolidation in the right middle lobe may possibly

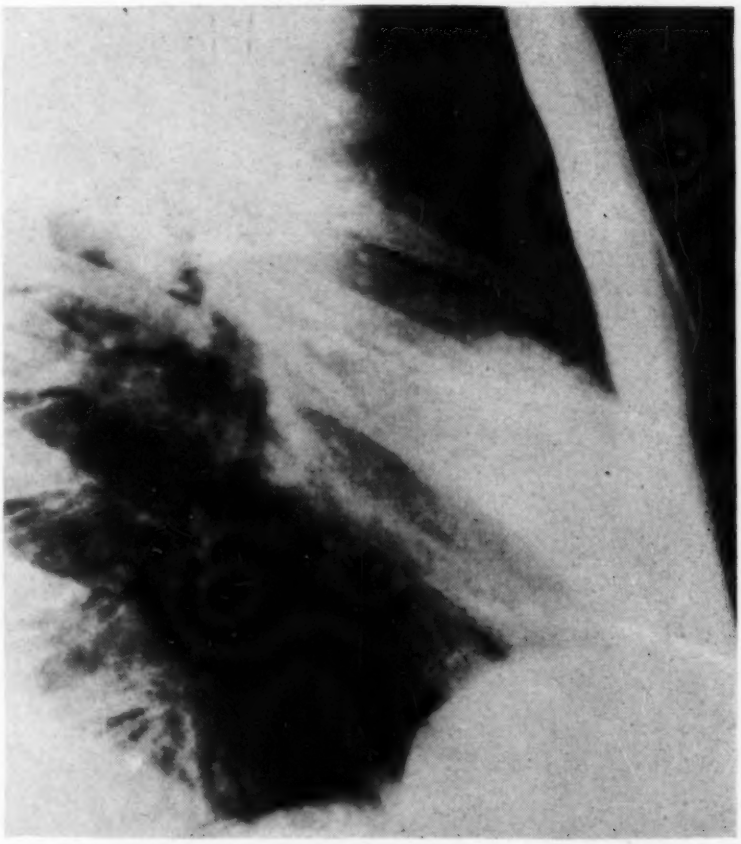

Figure 16d

Consolidation of Anterior Segment of Right Middle Lobe. Lateral radiograph of same patient.

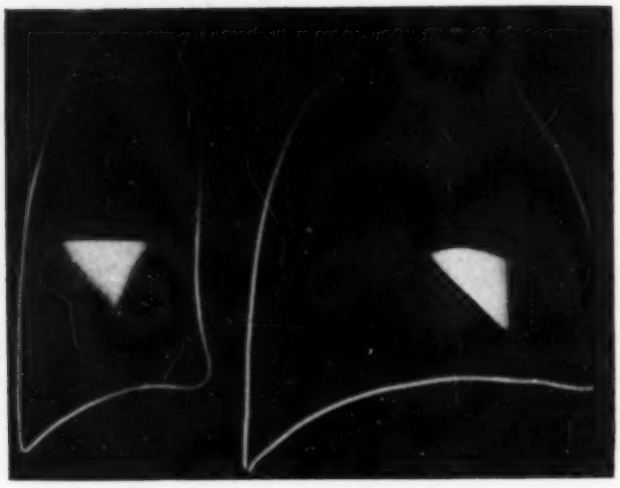

Figure 17a *Figure 17b*

Consolidation of Lateral Segment of Right Middle Lobe.
Fig. 17a: Postero-anterior radiograph of plasticene model.
Fig. 17b: Lateral radiograph of model.

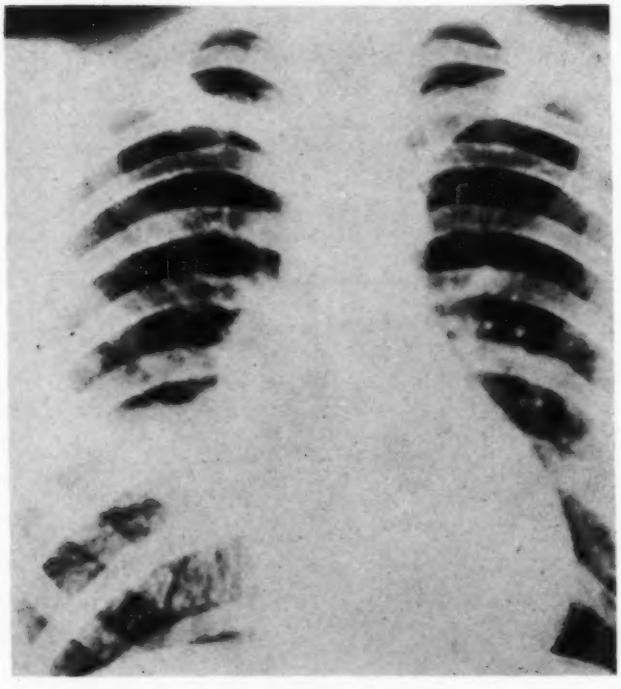

Figure 17c

Consolidation of Lateral Segment of Right Middle Lobe. Postero-anterior radiograph showing consolidation of right lateral middle segment due to atypical pneumonia.

be confused with an interlobar effusion, but in the lateral radiograph the fusiform, homogeneous opacity of an effusion is not seen. A bronchogram will usually distinguish between the two conditions by showing the relation of the middle bronchus to the shadow.

Minor Subdivisions of the Right Middle Lobe Segments.

No useful purpose is served by subdividing this lobe any further. Lucien and Weber[4] described a horizontal division between the upper and lower parts of the anterior middle segment.

Left Upper Lobe:

This lobe is equivalent to the combined upper and middle lobes of the right lung. Its bronchus divides into two branches, the ascending bronchus, corresponding to the eparterial bronchus and supplying the upper lobe proper, that is the part which is equiv-

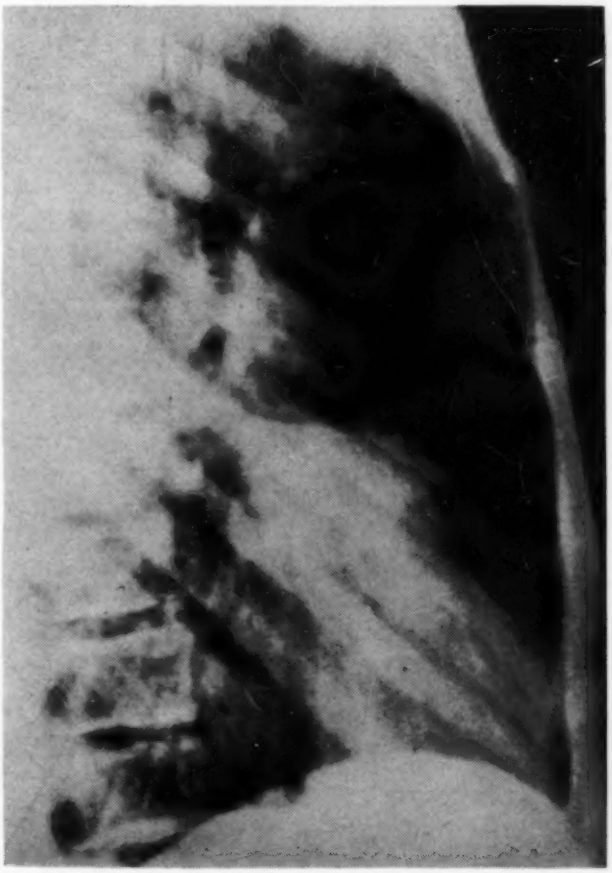

Figure 17d

Consolidation of Lateral Segment of Right Middle Lobe.
Lateral radiograph of same patient.

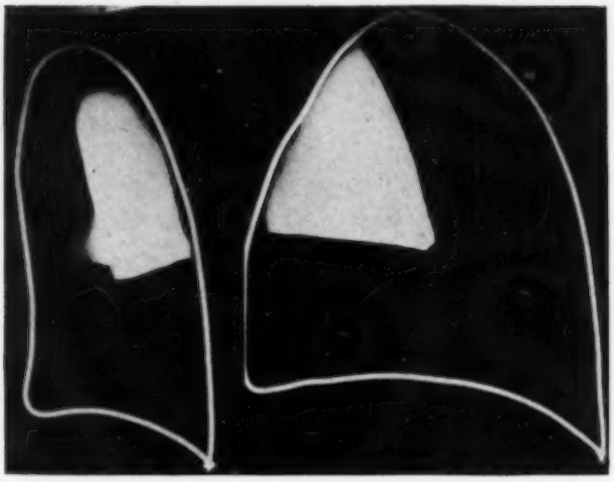

Figure 18a *Figure 18b*

Consolidation of Anterolateral Segment of Left Upper Lobe. *Fig. 18a:* Postero-anterior radiograph of plasticene model.— *Fig. 18b:* Lateral radiograph of model (Dr. L. G. Blair's case).

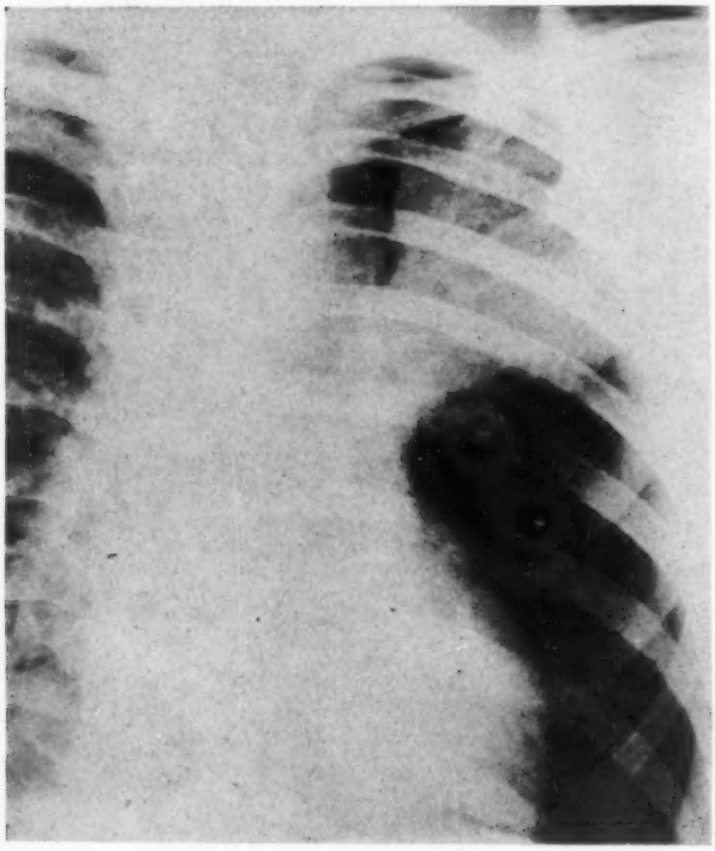

Figure 18c

Consolidation of Anterolateral Segment of Left Upper Lobe. Postero-anterior radiograph showing consolidation of left anterolateral segment due to primary tuberculosis with bronchial involvement (Dr. L. G. Blair's case).

alent to the right upper lobe; and the left middle bronchus which supplies the lingula or lingual process corresponding to the right middle lobe. There are four major segments in the left upper lobe, two in the upper lobe proper and two in the lingula.

A. *Left Upper Lobe Proper:*

(1) *Left Anterolateral Segment:* Consolidation of this segment has a very similar radiographic appearance to that of consolidation of the right anterolateral segment (Figs. 18a to 18d). There are only two minor differences; on the left side the lower border of the segment is less sharply defined as there is normally no fissure corresponding to the lesser fissure of the right lung; and the left anterolateral segment extends farther back than its fellow on the right side. The density variations in the radiographic shadows are also similar on the two sides.

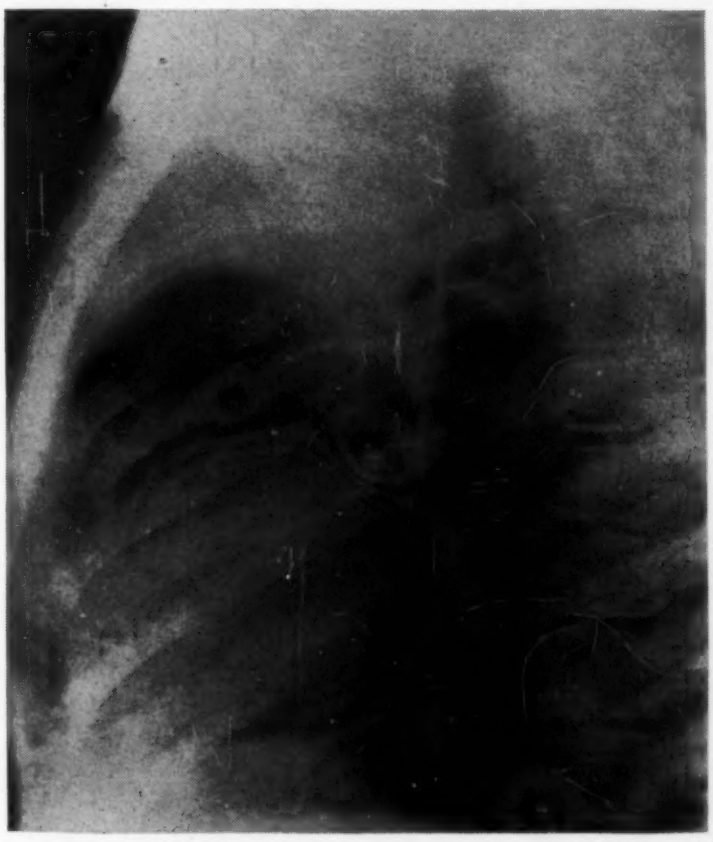

Figure 18d

Consolidation of Anterolateral Segment of Left Upper Lobe. Lateral radiograph of same patient; concave lower border of shadow indicates associated collapse (Dr. L. G. Blair's case).

When this segment collapses it sometimes tends to shrink inwards towards the hilum so that a clear area appears between it and the lateral chest wall in the postero-anterior radiograph (Figs. 19a and 19b).

(2) *Left Apicoposterior Segment:* This segment includes an area equivalent to the combined apical and posterolateral segments of the right lung. It is supplied by a single branch of the ascending bronchus. In the *postero-anterior* radiograph, consolidation of this segment appears as a large, homogeneous opacity, filling the apex of the lung above the 1st rib and extending downwards to the hilum (Fig. 20a). The outer border slopes from the 1st rib at the periphery downwards and slightly inwards to the level of the 6th or 7th rib posteriorly and then turns sharply inwards

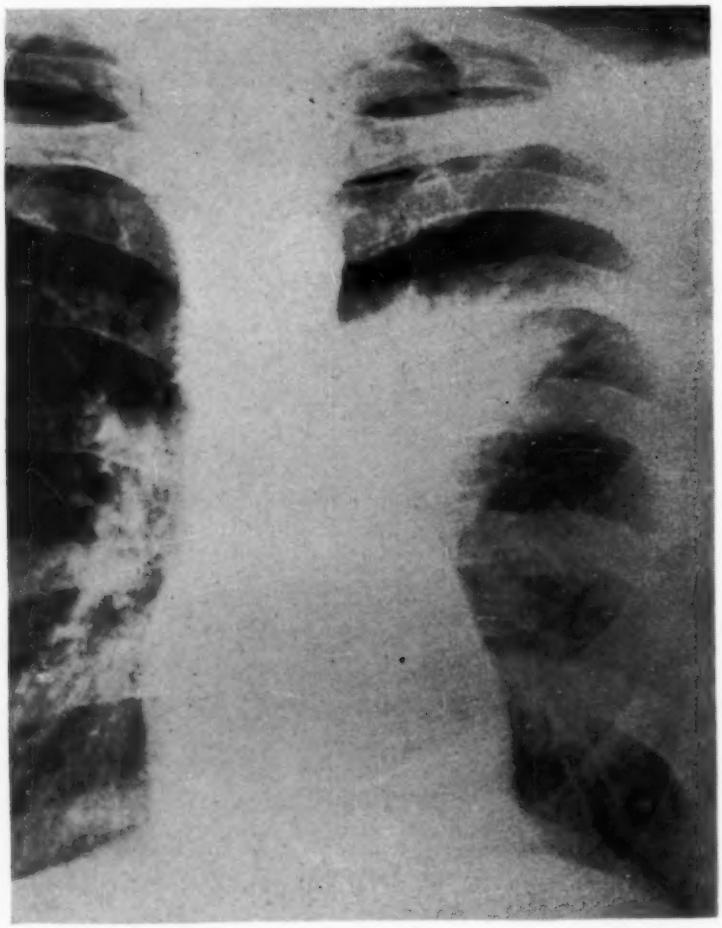

Figure 19a

Partial Collapse of Anterolateral Segment of Left Upper Lobe. Postero-anterior radiograph showing triangular, para-hilar opacity.

to reach the hilum. In the *lateral* radiograph (Fig. 20b) there is a dense opacity occupying the apex and posterior part of the upper chest where it merges into the superimposed shadows of the shoulder. The anterior margin slopes downwards and backwards to reach the interlobar fissure at the level of the 6th or 7th thoracic vertebra, behind the mid-axillary line. The postero-inferior margin is sharply defined and is bounded by the posterior end of the interlobar fissure, sloping upwards and backwards to the level of the 4th or 5th thoracic vertebra.

In the postero-anterior radiograph, collapse of the left apico-posterior segment gives a shadow which is smaller and less well-defined than that of consolidation, and the lateral border is usually concave. In the lateral view the collapsed segment appears as an elongated wedge lying along the posterior end of the fissure, with its apex at the hilum and its base fusing with the shoulder

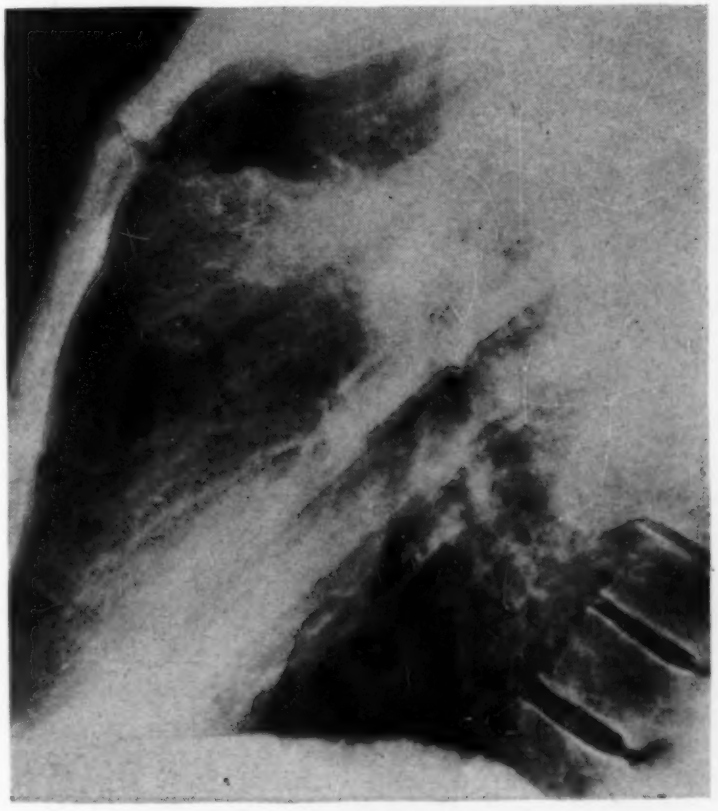

Figure 19b

Partial Collapse of Anterolateral Segment of Left Upper Lobe. Lateral radiograph showing wedge-shaped shadow extending forwards from hilum. Patient had a small, operable carcinoma obstructing anterolateral bronchus; confirmed by bronchography, bronchoscopy and pneumonectomy.

shadow. Sometimes, as the apicoposterior segment collapses, the anterolateral segment expands and extends upwards and backwards to fill the apex. In such a case, the postero-anterior radiograph will show aeration of the extreme apex (Fig. 20a) and the shadow may be mistaken for consolidation of the anterolateral segment; the true nature of the opacity is obvious in the lateral view.

B. *The Lingula or Lingual Process:*

The remaining two segments of the left upper lobe form the lingula or lingual process which is, in effect, the left middle lobe and is sometimes demarcated by a fissure. The lingula is equivalent to the right middle lobe and we have therefore adopted a similar nomenclature for its segments. The left middle bronchus, supply-

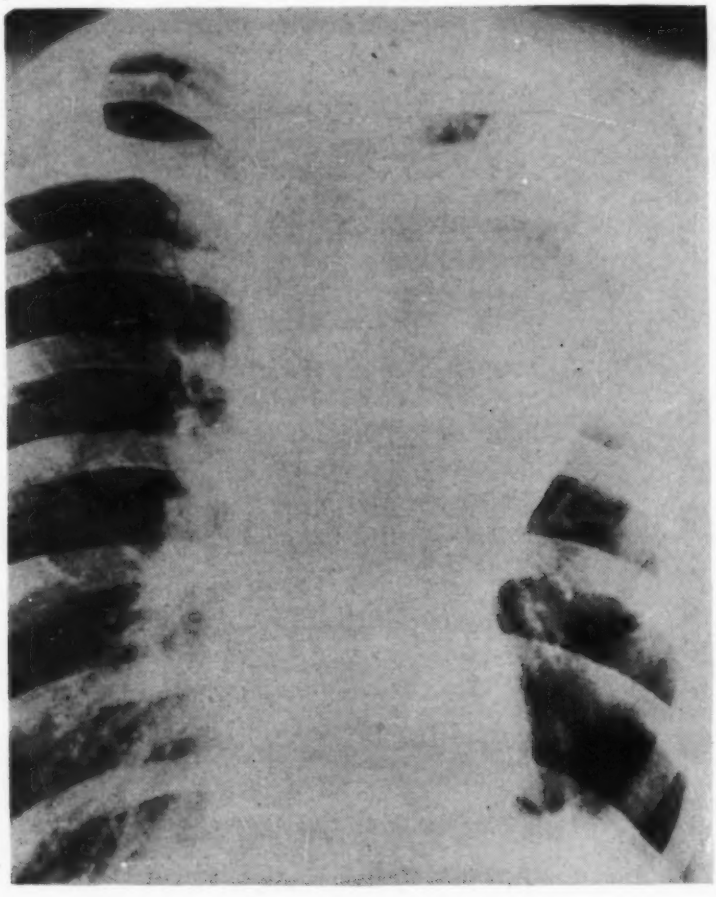

Figure 20a

Consolidation of Apicoposterior Segment of Left Upper Lobe. Postero-anterior radiograph of patient with malignant obstruction of apicoposterior bronchus.

ing the lingula, resembles the right middle bronchus in that it divides into its two segmental branches at some distance from the hilum. Consequently, lesions involving the lingula as a whole are very much commoner than those of its individual segments, and we find in practice that it is usually sufficient to regard this area as a single unit (Figs. 22a and 22b). In the lateral view, the lingula overlaps the heart and its anterior portion is a thin, tongue-like process closely applied to the pericardium. There is therefore very little difference in contrast between a consolidation in the lingula and the superimposed heart shadow; also the outline of the opacity is often blurred by the cardiac movement. It is often most difficult to tell from radiographs how much of the lingula is involved in a consolidation. A bronchogram does not always help and the orifices of the segmental bronchi are beyond the

Figure 20b

Consolidation of Apicoposterior Segment of Left Upper Lobe. Lateral radiograph of same patient. Slight aeration of extreme apex and concave margins of shadow indicate some collapse. Confirmed by bronchography and bronchoscopy.

Figure 21a *Figure 21b* *Figure 21c*

Segmental Lesions of the Lingula of the Left Upper Lobe. *Fig. 21a:* Postero-anterior radiograph showing consolidation of left anterior middle segment due to benign transient pneumonia; confirmed by bronchography.—*Fig. 21b:* Lateral radiograph of same patient showing triangular shadow superimposed on heart.—*Fig. 21c:* Lateral bronchogram showing left lateral middle segment outlined by alveolar filling.

range of bronchoscopic vision. Our experience has only provided a mere handful of proven examples of lingular segmental lesions.

(3) *Left Anterior Middle Segment:* Consolidation of this segment appears in the *postero-anterior* radiograph as a diffuse, wedge shaped opacity extending out into the left lung from the region of the apex of the heart and cardio-phrenic angle (Figs. 21a and 22a). The shadow is usually at the level of the anterior ends of the 6th and 7th ribs. In the *lateral* radiograph there is a triangular opacity with its base on the lower end of the sternum and tapering upwards and backwards to the hilum (Figs. 21b and 22b). The shadow is most dense in front and fades away as it reaches the hilum; the lower border is formed by the interlobar fissure but it is often difficult to distinguish against the heart shadow.

(4) *Left Lateral Middle Segment:* Consolidation of this segment gives a peripheral opacity in the left middle zone in the *postero-anterior* radiograph (Fig. 22a). The shadow is triangular, with its base on the lateral chest wall level with the 3rd to the 5th costal cartilages and its apex at the hilum. The medial border often blends with the heart shadow, which then hides the intersegmental junction and makes distinction between a consolidation of this segment and consolidation of the whole lingular impossible. Similarly in the *lateral* radiograph (Figs. 21c and 22b) a consolidation of the left lateral middle segment also overlaps the heart in front, so that its anterior margin is obscured. In this view, the opacity is triangular and extends backwards from the heart shadow; its lower border is formed by the fissure, sloping upwards

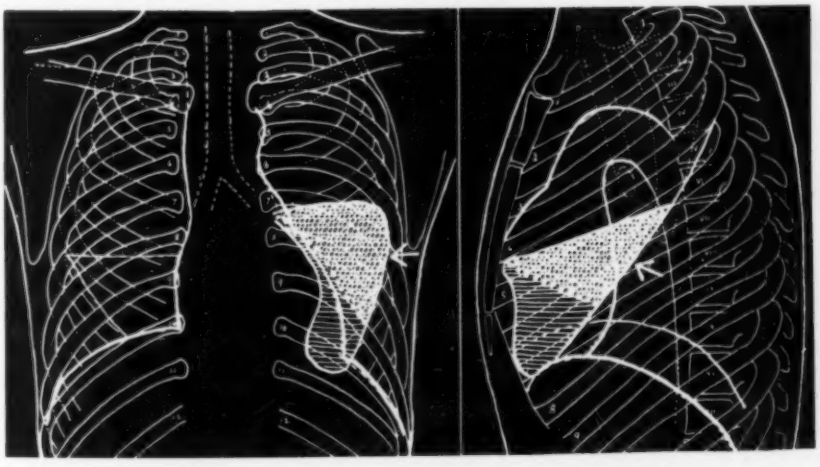

Figure 22a *Figure 22b*

Diagram of Radiographic Appearance of Lingular Segments. *Fig. 22a:* Postero-anterior view.—*Fig. 22b:* Lateral view. Arrow indicates lateral middle segment.

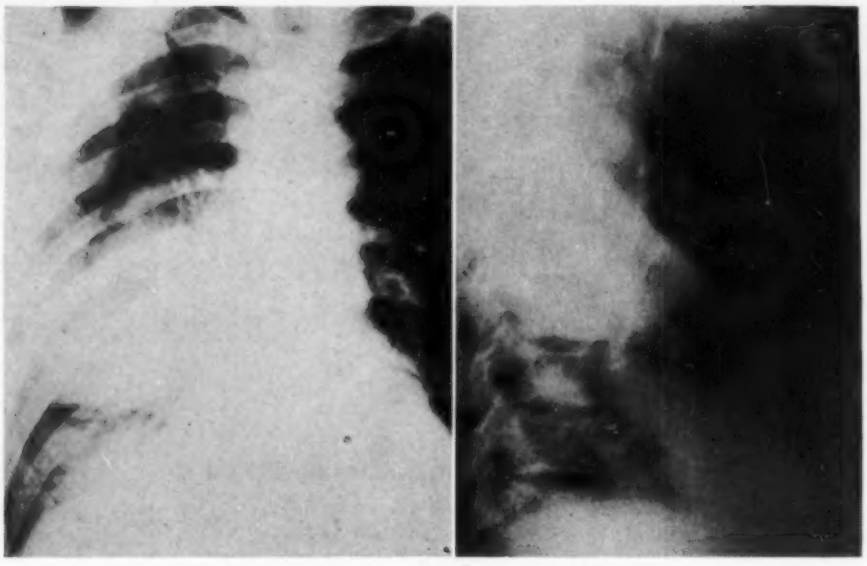

Figure 23a *Figure 23b*

Consolidation of Dorsal Segment of Right Lower Lobe. *Fig. 23a:* Postero-anterior radiograph of consolidation of right dorsal segment due to pneumonia.—*Fig. 23b:* Lateral radiograph of same patient (Dr. A. S. Watts's case).

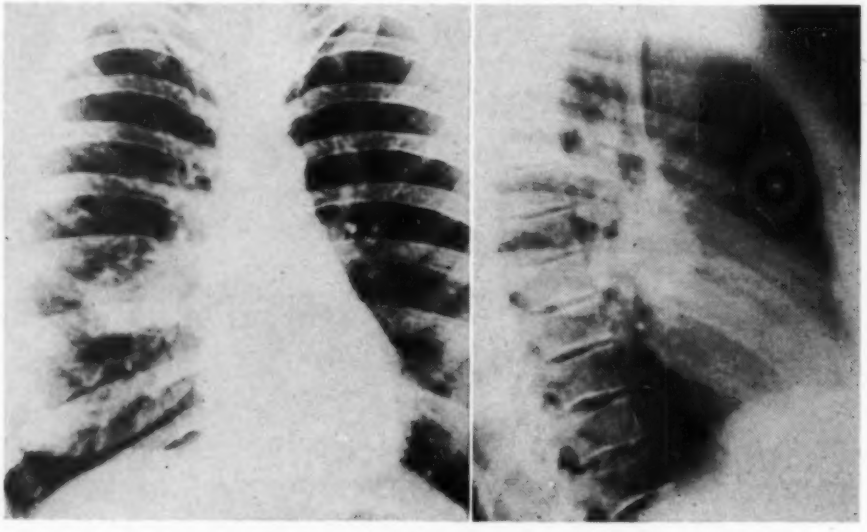

Figure 24a *Figure 24b*

Collapse of Dorsal Segment of Right Lower Lobe. *Fig. 24a:* Postero-anterior radiograph of patient with collapse of right dorsal segment due to chronic septic bronchopneumonia.—*Fig. 24b:* Lateral radiograph of same patient showing band-like shadow and descent of posterior end of greater fissure; confirmed at autopsy.

and backwards, while the upper border is directed backwards and slightly upwards from the 4th costal cartilage to join the fissure at about the level of the 5th rib in the posterior axillary line.

Collapse of an individual segment of the lingula is uncommon and difficult to diagnose radiographically for the reasons already given.

Minor Subdivisions of the Left Upper Lobe Segments (Fig. 15b).

The anterolateral division of the ascending bronchus splits into two principal branches, anterior and lateral. The subsegment served by the lateral branch is of some importance because it is usually large and is a common site for a lung abscess. The left anterolateral segment extends farther back than its fellow on the right side so that this lateral subsegment covers a large area in the mid-axilla from the 2nd rib above to the 4th or 5th rib below. The apicoposterior division of the ascending bronchus has two branches, apical and posterolateral, which are equiv-

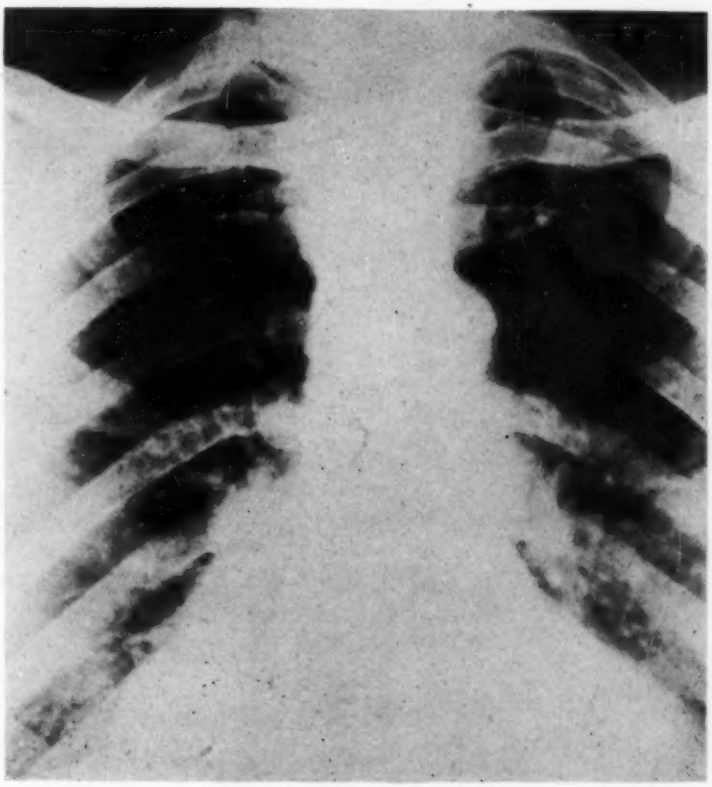

Figure 25a

Consolidation of Posterior Basic Segment of Right Lower Lobe. Postero-anterior radiograph of right posterior basic consolidation due to a lung abscess; confirmed by bronchography and bronchoscopy.

alent to the corresponding branches of the eparterial bronchus but are usually much smaller.

The anterior branch of the left middle bronchus commonly has two divisions, upper and lower, and the branch supplying the lateral middle segment may sometimes arise from one or other of these and not from the middle bronchus itself. This accounts for the variation in the description of these segments given by different workers. We are unconvinced of the practical value of such subdivision.

The Lower Lobes:

The two lobes are so similar that they may be considered together. The main difference between them is the presence of an additional segment, the cardiac, in the right lower lobe. In the lower mammals, such as the cat, the bronchial tree consists of a stem with a series of dorsal and ventral branches and the remains of this system may be seen in the human lower lobe.

Figure 25b

Consolidation of Posterior Basic Segment of Right Lower Lobe. Lateral radiograph of same patient.

There is always a large dorsal branch supplying the apex of the lobe and frequently a series of lesser dorsal branches below this. The stem has become twisted outwards so that the ventral branches have a lateral bearing (Lucien and Weber[4]). There are four major segments in the left lower lobe and five in the right lower lobe.

(1) *Dorsal Segment:* Consolidation of this segment appears in the *postero-anterior* radiograph as a massive hump-like shadow extending right across the middle zone of the lung (Fig. 23a). The upper border is convex and extends upwards to the level of the 5th or 6th rib posteriorly. The lower border is horizontal or concave, often tending to curve downwards as it reaches the heart, and lies at the level of the 9th or 10th rib posteriorly. This segment often has a para-vertebral prolongation which extends down on the medial surface of the lobe as far as the 10th or 11th thoracic vertebra, but this paravertebral part is usually hidden by the heart shadow in the postero-anterior view. In the *lateral*

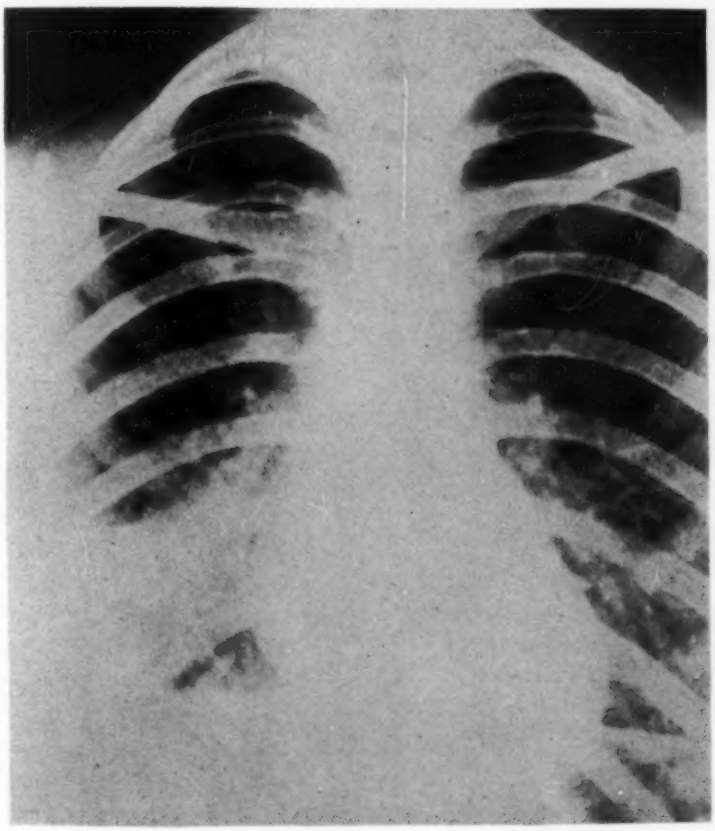

Figure 26a

Consolidation of Anterior Basic Segment of Right Lower Lobe. Postero-anterior radiograph of right anterior basic consolidation due to atypical pneumonia; confirmed by bronchography.

radiograph, consolidation of the dorsal segment gives a characteristic triangular opacity (Fig. 23b). Based on the posterior chest wall, the shadow is bounded above by the sharp line of the interlobar fissure and its lower margin slopes downwards and backwards towards the region of the 10th thoracic vertebra, becoming indistinct as it overlaps the spinal column. The apex of the shadow, in this view, extends forwards to the mid or anterior axillary line at about the level of the 5th rib in front. The dorsal segment is sometimes demarcated by a fissure which may be seen in the radiographs.

When the dorsal segment is collapsed the size of the shadow in the postero-anterior radiograph is much reduced and does not extend to the lateral chest wall (Fig. 24a). It appears as a

Figure 26b

Consolidation of Anterior Basic Segment of Right Lower Lobe. Lateral radiograph of same patient; the shadow is abnormally narrow owing to associated collapse.

small opacity extending out from the mediastinum at the level of the 7th or 8th rib posteriorly. In the lateral radiograph the collapsed dorsal segment casts a narrow, wedge-shaped shadow and the posterior end of the interlobar fissure is often drawn downwards to a more horizontal position (Fig. 24b).

(2) *Posterior Basic Segment:* The bronchus supplying this segment represents the terminal part of the stem bronchus and has a series of small dorsal branches. Consolidation of the posterior basic segment appears in the *postero-anterior* radiograph as an opacity extending out from the lower part of the heart shadow and obliterating the cardio-phrenic angle (Fig. 25a); on the left side it is often hidden behind the heart. The outer margin slopes downwards and outwards from the hilum to the diaphragm. In

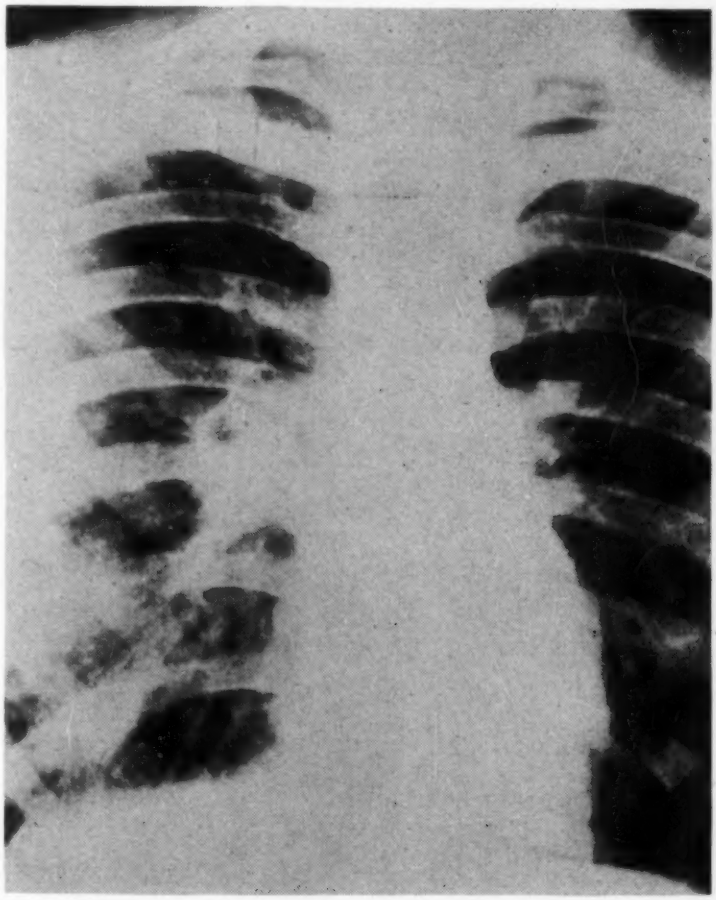

Figure 27

Collapse of Right Anterior Basic Segment. Postero-anterior radiograph showing patchy right basal opacity. Patient had an atypical pneumonia with obstruction of right anterior basic bronchus; confirmed by bronchography.

the *lateral* radiograph, consolidation of this segment appears as a well defined, triangular shadow with its apex at the hilum and its base in the posterior costo-phrenic sulcus, extending upwards at the back as far as the 9th or 10th thoracic vertebra (Fig. 25b).

Collapse of this segment reduces the size of the shadow in the postero-anterior view and appears in the lateral radiograph as a narrow band extending from the hilum to the costo-phrenic sulcus.

(3) *Anterior Basic Segment:* This area is supplied by the first ventral branch of the lower lobe stem, which is directed for-

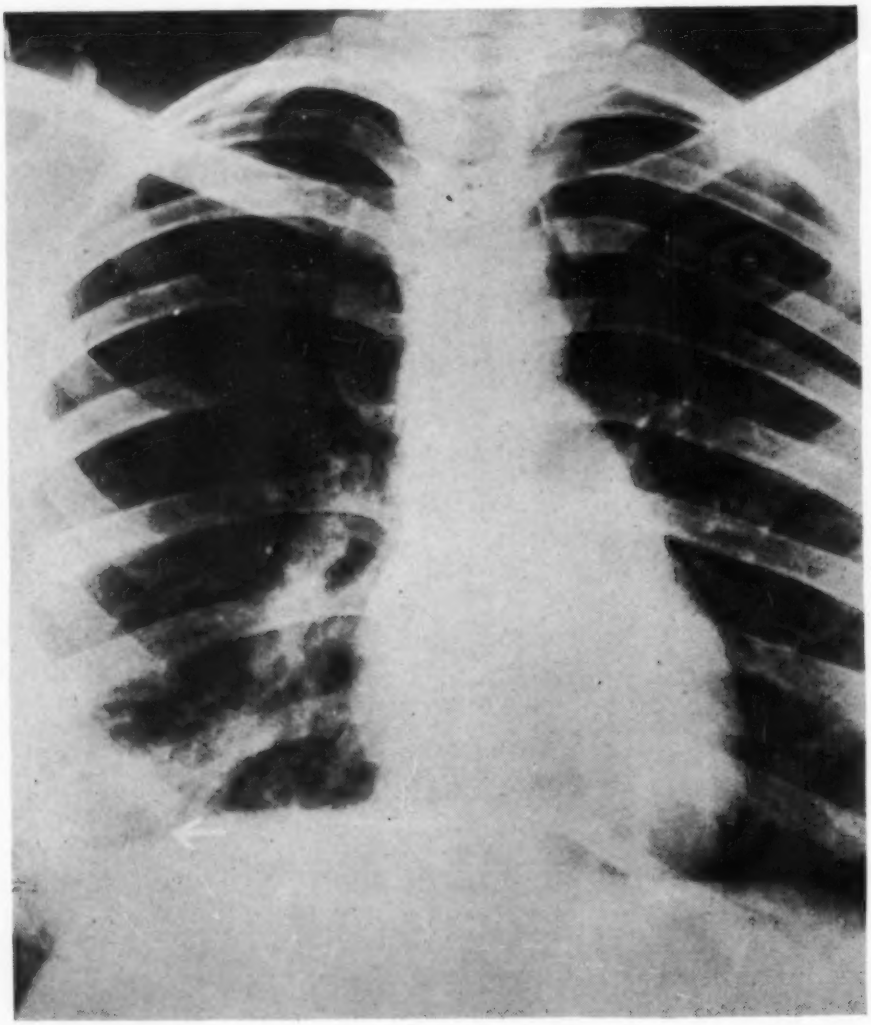

Figure 28a

Consolidation of Middle Basic Segment of Right Lower Lobe. Postero-anterior radiograph showing consolidation and cavitation of right middle basic segment due to tuberculosis; note lateral position of lesion in this view.

wards, downwards and laterally. When consolidated, this segment casts a very characteristic radiographic shadow. In the *postero-anterior* view, the shadow is cuneiform and is based upon the diaphragm and the adjoining part of the lateral chest wall, obliterating the costo-phrenic angle (Fig. 26a). The apex of the shadow is at the hilum and it decreases in density from without inwards. The upper border leaves the lateral chest wall about level with the anterior end of the 4th rib and slopes upwards and medially to reach the hilum at the level of the anterior end of the 3rd rib. The lower border slopes upwards and medially from the centre of the diaphragm to join the upper border at the hilum, so that

Figure 28b

Consolidation of Middle Basic Segment of Right Lower Lobe. Lateral radiograph of same patient. Arrows indicate cavity.

the cardio-phrenic angle remains clear. In the *lateral* radiograph, consolidation of the anterior basic segment appears as a dense homogeneous solid wedge extending downwards and forwards from the hilum to reach the diaphragm in front of the mid-axillary line (Fig. 26b). The anterior border is sharply defined and is formed by the interlobar fissure. The posterior margin is usually clear cut and runs almost parallel to the anterior margin though the shadow is broader at its base than at its apex.

When this segment collapses, the shadow becomes a narrow band in the lateral view and may be mistaken for thickening of the interlobar fissure. In the postero-anterior view, the collapsed anterior basic segment casts an ill defined, patchy shadow (Fig. 27).

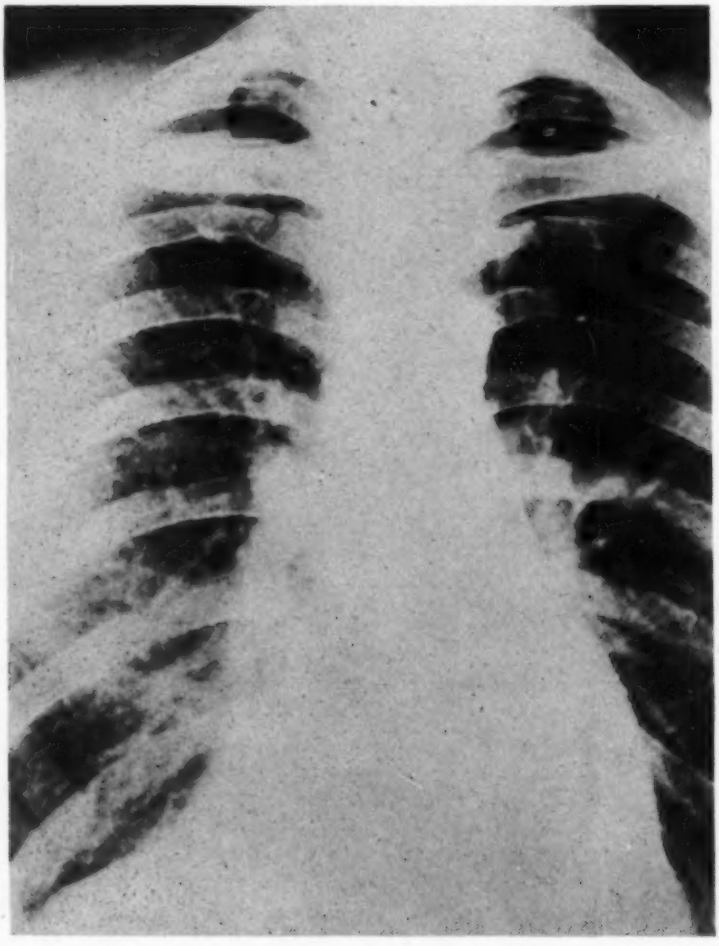

Figure 29a

Consolidation of Cardiac Segment of Right Lower Lobe. *Fig. 29a:* Postero-anterior radiograph showing shadow obliterating right cardio-phrenic angle.

Consolidation of the anterior basic segment is often mistaken for an interlobar effusion, but it is not usually difficult to separate the two conditions. An interlobar effusion casts a much more uniformly dense shadow and in the lateral view it is fusiform in shape, in contrast to the straight edged shadow of the consolidated segment. Bronchography will, of course, distinguish between the two with certainty.

(4) *Middle Basic Segment:* This segment is supplied by the second ventral branch of the lower lobe stem which is directed downwards and laterally. In the *postero-anterior* radiograph, consolidation gives a shadow very similar to that of an anterior basic consolidation. The maximum density of the opacity lies at the costo-phrenic angle whence the shadow tapers upwards and inwards towards the hilum, becaming less dense as it nears its apex. In the *lateral* radiograph, consolidation of this segment appears as a homogeneous, wedge-shaped opacity based on the diaphragm

Figure 29b

Consolidation of Cardiac Segment of Right Lower Lobe. *Fig. 29b:* Lateral radiograph of same patient showing triangular opacity based on middle of diaphragm; bronchography showed dilatation of branches of cardiac bronchus.

behind the mid-axillary line. Sometimes this middle basic segment lies almost directly lateral to the posterior basic segment and, in the lateral view, it then resembles a posterior basic consolidation, from which it can be distinguished by its lateral position in the postero-anterior radiograph (Figs. 28a and 28b).

(5) *Right Cardiac Segment:* Consolidation of this segment appears in the *postero-anterior* radiograph as a small opacity filling in the right cardio-phrenic angle (Fig. 29a). In the *lateral* view it casts a small triangular shadow, based on the diaphragm rather behind its centre, with the apex of the shadow pointing upwards towards the hilum (Fig. 29b).

Collapse of the cardiac segment may be hidden behind the heart in the postero-anterior radiograph; in the lateral view it gives a small linear shadow extending almost vertically downwards from the hilum to the diaphragm.

The cardiac bronchus is usually represented in the left lung by a medial branch of the anterior basic bronchus, but occasionally it arises independently and supplies a separate segment, as on the right side.

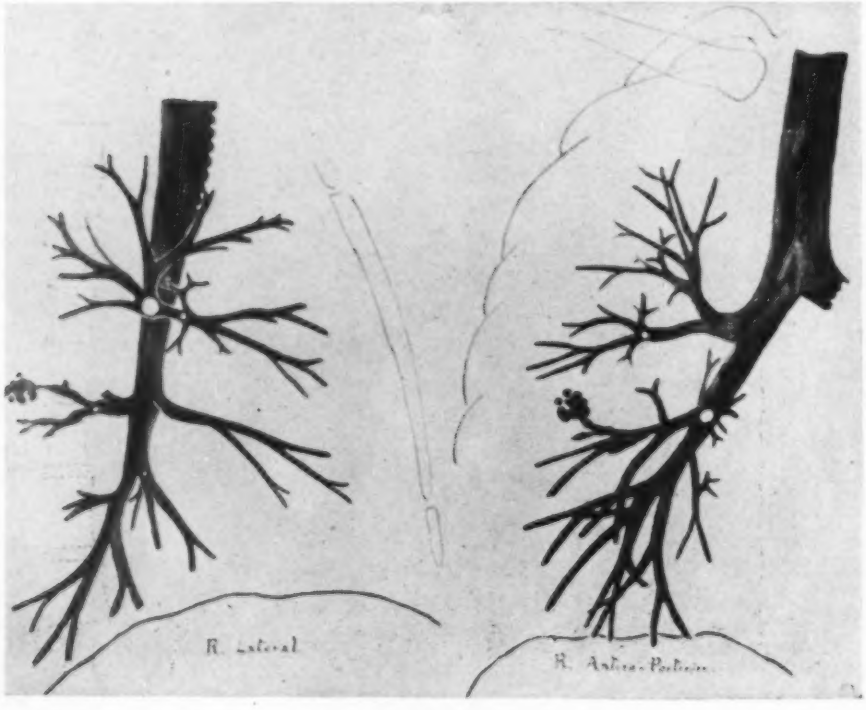

Figure 30

Bronchiectasis in Lateral Subdivision of Right Dorsal Segment. Tracings of a bronchogram showing localized dilatation in lateral branch of right dorsal bronchus; note lateral position of lesion in frontal view.

Minor Subdivisions of the Lower Lobe Segments (Figs. 15c-15d).

The dorsal bronchus commonly has three branches, apical, lateral and medial (Lucien and Weber,[17] Brock[12] The lateral part of the dorsal segment extends right out to the mid-axilla; lesions of it may be mistaken for disease of the middle lobe or lingula in postero-anterior radiographs, but lateral films reveal their true position (Fig. 30).

The upper part of the posterior basic segment can be subdivided into one or more parallel segments lying below the dorsal segment and supplied by minor dorsal branches of the stem bronchus (Neil et al.[5]). Occasionally one of these subsegments is involved separately in a disease process (Figures 31a and 31b). Both the anterior and middle basic bronchi have a large lateral branch, arising soon after their origin from the stem, but there is no need to subdivide these segments.

THE APPLICATIONS OF SEGMENTAL ANATOMY

There are many reasons why a knowledge of segmental anatomy has great value. Morbid changes of many kinds can be confined to a segment, and segmental lesions can be detected radiologically. But only in recent years has the contribution which their identi-

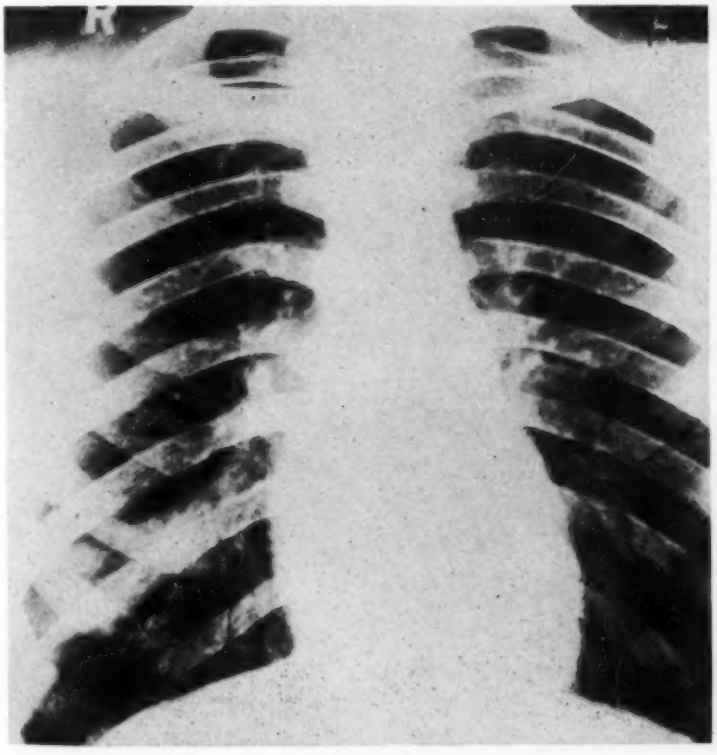

Figure 31a

Consolidation of Subdorsal Part of Right Posterior Basic Segment. Postero-anterior radiograph showing consolidation of subdorsal division of right posterior basic segment due to tuberculosis.

fication makes towards accurate diagnosis and treatment been fully recognized.

Perhaps the most important contribution to diagnosis is that recognition of a segmental lesion directs attention to the condition of the related bronchus. Although it may prove to be normal, we can never afford to omit investigation of the bronchus when such a lesion persists or recurs; for the odds are then strongly in favor of finding an abnormal or obstructed bronchus, with a growth or stricture as the commonest cause. In fact, one of the best examples of the value of segmental anatomy is to be seen in bronchial carcinoma. Here, with a radiograph showing a large pulmonary opacity, it may be thought that this entire shadow is due to growth. But the growth itself is often small and the rest

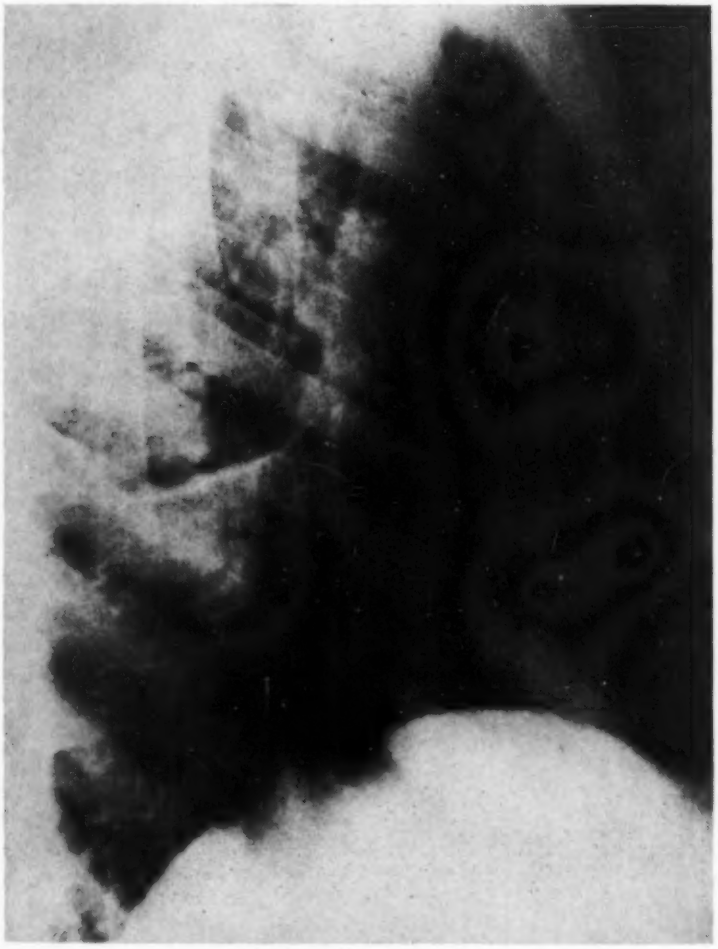

Figure 31b

Consolidation of Subdorsal Part of Right Posterior Basic Segment. Lateral radiograph of same patient.

of the shadow due to consolidation or collapse of the pulmonary segment supplied by the affected bronchus. Thus recognition of the segmental nature of the lesion not only ensures prompt diagnosis and often indicates operability, but also it enables irradiation to be concentrated upon the small area where the growth is situated.

Blair, in a personal communication, points out that, in general, pneumonic lesions always tend to transgress the segmental boundaries or to affect less than a whole segment; a point which is especially true of atypical pneumonias. A truly segmental involvement is evidence against a simple pneumonic process.

A knowledge of these respiratory districts and of the appearance, position and direction of the bronchi which supply them, is essential when planning treatment by postural drainage. Such treatment is valueless and may even be dangerous if the patient is not put into the correct position which ensures dependent drainage for the affected segments. This was stressed by Nelson[3] in 1932, but is still imperfectly understood, so that patients are often "drained" face downwards, when they ought to be lying in some other position (Foster-Carter[10]).

Another important application of segmental anatomy is in the diagnosis, localization and external drainage of a lung abscess. Early recognition is essential for the successful treatment of an acute putrid abscess, and the condition is always segmental at its onset. If it is not recognized and treated at this stage, the infection spreads, simple drainage becomes ineffective and the prognosis deteriorates rapidly. External drainage of a lung abscess must be localized to the affected segment so that normal lung tissue is not transgressed; this subject has been fully described by Brock[12] in recent papers. The value of bronchoscopy in localizing a lung abscess has been emphasized in the past (Kramer and Glass[2]); but variations in the bronchial tree and individual segments (Behr and Huizinga[6]; Foster-Carter[9]; Brock[12]; Appleton[18]) make bronchoscopy an unreliable guide unless it is used to supplement careful radiological studies.

The surgical resection of separate broncho-pulmonary segments, particularly the lingula, dorsal and anterolateral segments, is sometimes possible and has been used in the treatment of segmental bronchiectasis (Churchill and Belsey[19]; Blades[20]).

A further application of segmental anatomy concerns the pathogenesis of certain pulmonary infections. A segmental distribution has been taken to indicate that such lesions are due to bronchial embolism. Though there is no doubt that this is sometimes the right explanation (Hamburger and Robertson[21]; Brock, Hodgkiss and Jones[22]) it must not be forgotten that each segment has its

own arterial supply and that the branches of the pulmonary artery follow the distribution of the minor bronchi very closely (Appleton[23]). Therefore, the fact that a pulmonary lesion has a segmental distribution is no proof of bronchial embolism. A small infarct gives an identical picture (Westermark[24]; Shirley-Smith[25]).

The fact that post-primary tuberculous lesions are sometimes segmental (Figs. 31a and 31b) has been taken as evidence of their bronchogenic origin. But a segmental lesion alone is actually an argument against the condition being tuberculous, for most solitary segmental lesions are due to other causes. Primary tuberculosis, which more often produces segmental changes, does so by glandular obstruction of the bronchus much more commonly than by bronchogenic infection of the parenchyma, and segmental lesions in adult phthisis often indicate bronchial tuberculosis (Westermark[26]).

SUMMARY

The segmental conception of pulmonary anatomy is not new, but has become increasingly important in recent years. A bronchopulmonary segment is defined as that area of lung supplied by a principal branch of a lobar bronchus. On this basis, each lung is divided into a convenient number of major segments. We have described in detail methods of investigating segmental anatomy and radiology, and also the radiological features of each segment as illustrated by consolidation and collapse. Pulmonary segments are variable units of a mobile structure and are, therefore, only susceptible of approximate anatomical description. Thus, variations in the appearance of their lesions are not uncommon.

The detection of a segmental lesion in the lung immediately concentrates attention upon the related bronchus, which is then so often found to be abnormal. This has an important bearing upon the diagnosis and early treatment of bronciahl growths.

Other applications of segmental anatomy are described.

We are indebted to many colleagues and friends for their useful criticism and for the loan of radiographs; to Dr. L. G. Blair, Dr. J. W. Clegg, and their staffs in the Departments of Radiology and Pathology at the Hospital; and to Mr. J. V. Spence for technical assistance.

RESUMEN

La concepción segmentaria de la anatomía pulmonar no es nueva, pero su importancia ha aumentado más y más en los últimos años. Un segmento broncopulmonar es el área del pulmón que comunica con una rama principal de un bronquio lobular. De acuerdo con esta definición, cada pulmón se divide en un número conveniente de segmentos mayores. Hemos descrito con detalle métodos para

investigar la anatomía y radiología segmentarias y, además, los rasgos radiológicos distintivos de cada segmento ilustrados por la consolidación y el colapso. Los segmentos pulmonares son unidades variables de una estructura movible y, por lo tanto, sólo puede darse una descripción aproximada de su anatomía. Así no es raro que varíe el aspecto de sus lesiones.

El descubrimiento de una lesión segmentaria en el pulmón inmediatamente concentra la atención sobre el bronquio correspondiente, el que, a su vez, con mucha frecuencia se encuentra anormal. Esto es de mucha importancia en el diagnóstico y oportuno tratamiento de tumores bronquiales.

Se describe otras aplicaciones de la anatomía segmentaria.

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Roentgen Treatment for Hodgkin's Disease and Lymphosarcoma of the Chest

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Fifty years ago, Roentgen announced to the world his discovery of peculiar rays which had the property of passing through substances of low atomic weight. Not knowing what these rays were, he called them "X-rays". This discovery caused a tremendous sensation, and within a few months the new rays were already being applied to the examination of fractures and dislocations of bones, to find foreign bodies and to determine the possible influence of the rays on certain pathologic conditions. Now, after half a century, what does one find? Every hospital and clinic has a more or less important department of roentgenology, and every practicing physician must make use of Roentgen's rays for diagnosis and for treatment. For a physician to practice medicine without the help of these rays would now seem an unbelievable anachronism and would label him an old fogy.

Whenever treatment with roentgen rays is mentioned, lay persons as well as many physicians immediately assume that treatment of malignant tumors is meant. This is far from true. At the present time and for some years roentgen rays have been used increasingly for the treatment not only of tumors but also of inflammatory conditions, acute and chronic. In several previous communications I have dealt with the treatment of inflammatory lesions. In this paper I shall attempt to set forth basic ideas about the treatment of malignant neoplasms, especially as it applies to neoplasms of the chest. But in order to understand how this kind of treatment acts on tumors it is important to know certain fundamental principles which are based on a large body of experimental evidence as well as on extended clinical observations.

SENSITIVENESS OF NORMAL CELLS

Each variety of cell in the body is specifically sensitive to roentgen rays. Certain varieties of cells are extremely sensitive and are destroyed or injured by small doses; other varieties are resistant and can tolerate large doses with apparent impunity. This does not imply that a given dose of rays can destroy all cells of a given variety in the irradiated territory, because the sensitiveness of any kind of cell varies somewhat from cell to cell. It

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would be more accurate to say, therefore, that each variety of cell has a specific range of sensitiveness.

When cells of a given kind are exposed to a certain dose of radiation, some are destroyed, some are injured but regenerate later, and some do not show any deleterious effect. This variation in the susceptibility of different cells of the same kind is probably due to the metabolic stage of the cells and perhaps to other unknown factors. Whatever the main reason for variation in the radiosensitiveness of different cells of the same variety may be, this does not affect the fundamental law of the specific sensitiveness of different varieties of cells, a law based on innumerable experiments on animals and substantiated by extensive clinical observation.

According to present knowledge, cells may be classified, in the order of the degree of their sensitiveness, as follows:

Lymphoid cells (lymphocytes in the spleen, lymph nodes, intestinal lymph follicles, circulating blood, bone marrow, thymus, tonsil and other structures in which these cells may be present).

Polymorphonuclear leukocytes and eosinophils in the blood or tissues.

Epithelial cells: (1) basal epithelium of certain secretory glands, especially the salivary glands; (2) basal epithelium (spermatogonial cells) of the testis and follicular epithelium of the ovary; (3) basal epithelium of the skin, mucous membranes and certain organs, such as the stomach and small intestine; (4) alveolar epithelium of the lungs and epithelium of bile ducts (liver) and (5) epithelium of tubules of the kidneys.

Endothelial cells of blood vessels, pleura and peritoneum.

Connective tissue cells. Bone cells.

Muscle cells. Nerve cells.

Although the difference in susceptibility between the most sensitive and the least sensitive varieties of cells is considerable, no cell in the body is wholly invulnerable to radiation; all cells, whatever their variety, may be destroyed or injured if exposed to a sufficiently large dose of rays, especially if doses within the therapeutic range are disregarded. The experiments of Bergonié and Tribondeau[1-9] and others have shown conclusively that the younger and the more active the cell, from a metabolic point of view, the more susceptible it is to the influence of the rays. Cells which naturally undergo rapid mitotic division and the life cycle of which, therefore, is comparatively short are most sensitive; and cells which have a long life cycle are relatively resistant to the rays. But the relation of the age of the cells to the relative sensitiveness is less important than the specific vulnerability of the different varieties of cells.

In order to give a clear idea of the effect of irradiation on cells, I shall describe the changes which can be observed in sensitive cells, such as lymphocytes, after exposure to roentgen rays.

The exceptional sensitiveness of lymphocytes was established by the early experiments of Heineke[10-12] and has since been fully confirmed by Krause and Ziegler,[13] Fromme,[14] Jolly,[15] Tsuzuki,[16] Piepenborn,[17] Warthin[18] and many others. When the entire body of an animal is exposed to roentgen rays, the spleen, the mesenteric and other lymph nodes, the intestinal lymph follicles, the blood and bone marrow, the thymus in young animals and other collections of lymphoid tissue show a more or less marked destruction of lymphocytes, and the degree of destruction is proportional to the dose of rays and to the interval between irradiation and death. As the number of intact lymphocytes in the spleen and lymph nodes diminishes, the stroma becomes more prominent, and this feature may become so pronounced that the malpighian corpuscles or lymph follicles may largely disappear and may be recognized only by the blood vessels and by the concentric arrangement of the corpuscular or follicular stroma. Heineke found destruction of lymphocytes two hours after irradiation, but Warthin, who examined the lymphoid structures sooner after exposure to the rays, found unmistakable evidence of lymphocytic disintegration within fifteen minutes after irradiation.

The destruction of these cells is characterized by disorganization and fragmentation of the nuclear chromatin and by scattering of the fragments of chromatin between the remaining intact cells and in the spaces of the reticular stroma, where the fragments gather into clumps or balls. The extent and the duration of this destructive phase depend on the intensity of irradiation. It may continue from one to several days and may be accompanied by a progressive reduction in volume or atrophy of the affected lymphoid structures. Then the clumps or balls of degenerate chromatin are gradually taken up by some of the reticular cells, which assume a phagocytic property and swell as the amount of ingested chromatin debris increases. The phagocytic disposal of chromatin material from the destroyed cells may continue until the lymphocytes are largely destroyed, but a certain proportion of the cells appear to resist the action of the rays. Some hours or days later, the phagocytic reticular cells themselves begin to disappear. The chromatin debris ingested by the phagocytes apparently undergoes intracellular digestion, because the number and size of the ingested fragments diminish steadily. From seven days to three weeks after irradiation, more or less regeneration of lymphoid tissue may be observed.

Similar changes occur in other kinds of cells but, because they

are less sensitive, a larger dose of rays is required to produce an equivalent effect or, if the dose of rays is the same, fewer cells are affected and the effect is less pronounced. Also, the cellular changes induced by irradiation do not begin so soon after exposure and do not last so long. This difference increases as the relative sensitiveness of other kinds of cells decreases.

SENSITIVENESS OF MALIGNANT TUMORS

The sensitiveness of tumors to roentgen rays corresponds closely to that of the cells of which the tumors are chiefly composed. Thus, tumors derived from lymphoid cells or from the basal cells of the genital glands (testis or ovary), as well as from the embryonal epithelium of the kidney in children (Wilms' tumor), are extremely sensitive. Neoplasms arising from adult epithelium are only moderately sensitive and tumors derived from connective tissues are much more resistant. Like different varieties of normal cells, malignant tumors of different kinds can be classified according to their sensitiveness to roentgen rays. Elsewhere I have ventured to make such a classification, and those who may be interested will find the reference in the bibliography.[19]

Knowledge of the comparative sensitiveness of different kinds of neoplasms often makes it possible to distinguish certain varieties of tumors from other varieties which are more or less sensitive, and this method can often furnish information of the greatest value and could be employed much more than it now is. Thus, in connection with intrathoracic tumors, exposure to roentgen rays almost always permits one to establish a clear distinction between Hodgkin's disease or lymphosarcoma and an aneurysm of the aorta, between these forms of lymphoblastoma and carcinoma of a bronchus, neurofibroma, fibrosarcoma, teratoma, or a desmoid tumor, or between lymphoblastoma and tuberculous adenitis. Moreover, when the action of roentgen rays on a tumor is correlated with the history, clinical features and physical findings, the diagnostic value of this therapeutic test can be extended considerably. Needless to say, the use of this test requires extended experience and, as will be explained later, the treatment must be arranged in a certain manner. Mere exposure to a roentgen tube in operation is not sufficient.

CLINICAL AND OTHER CONSIDERATIONS

Before considering roentgen treatment for these conditions, it would not be amiss, perhaps, to review a number of points which often have an important bearing on treatment.

In the average case, from a clinical as well as from a therapeutic point of view, these forms of lymphoblastoma are identical. By

this I mean that, in both of these conditions, the pathologic process can begin in the same region and can invade other groups of nodes in precisely the same manner and at the same rate. Clinically, in other words, there is no essential difference between them. From the standpoint of treatment, also, these conditions are influenced by a given dose of roentgen rays in the same manner and at the same average rate. In the past, some writers have claimed that lymphosarcoma is more sensitive to roentgen rays than Hodgkin's disease, and vice versa. This contention, I am convinced, has been based on limited experience. After having treated more than 5,000 patients during the past twenty-five years, I have been forced to conclude that, in the average case, these conditions are so nearly identical that one cannot be distinguished from the other, either clinically or therapeutically. To me they appear to be members of the same family.

Hodgkin's disease and lymphosarcoma are more common than earlier writers have led one to believe. This is probably because these conditions begin very insidiously; because, in the past, they were often mistaken for other conditions, such as tuberculous adenitis; and because, even now, in some cases the disease is not recognized until the pathologic process has reached a rather advanced stage. Another reason is that too much attention has been concentrated on the lymph nodes in the neck, armpits and groins. It is true that these conditions often begin in the cervical lymph nodes or in the nasopharynx or tonsil, but when any or all of these structures are involved, this does not necessarily mean that the process began there. In about an equal percentage of cases these conditions begin in the retro-abdominal lymph nodes, especially the para-aortic or iliac nodes, but sometimes the mesenteric nodes also are affected sooner or later.

As far as the lymph nodes in the chest are concerned, those in the mediastinum (right and left paratracheal nodes or tracheobronchial nodes, or both) are most commonly involved. However, Hodgkin's disease or lymphosarcoma begins in the mediastinal nodes much less commonly than it begins in the head, neck, or retro-abdominal nodes. In most cases, when the mediastinal nodes are invaded, the involvement of these nodes is secondary to similar, but earlier, involvement of lymph nodes in other regions.

An interesting, and sometimes an important, point to remember is that, when lymph nodes in the axilla are affected by these conditions, the mediastinal nodes also are usually involved, although in some cases involvement of these nodes cannot be demonstrated easily because the nodes have not become sufficiently large to project beyond the borders of the sternum and spinal column; and the reverse is often true, but the latter is less common than

the former. Similarly, when the inguinal nodes are affected, it can almost be taken for granted that the retro-abdominal (para-aortic, mesenteric or iliac) nodes also are involved. In 1939 I[20] drew attention to these points, and since then Symmers[21] (1944) has confirmed their validity by extended observations at necropsy.

By physical examination alone, as most physicians know, it is often difficult or impossible to recognize intrathoracic involvement in these conditions, and even when roentgenoscopy or roentgenography is employed, it may be impossible to distinguish Hodgkin's disease or lymphosarcoma from other neoplastic processes, such as carcinoma, neurofibroma, fibrosarcoma, teratoma, thymoma, or the so-called Pancoast tumor. This is especially true during the early stage, but it is often true at any stage. One reason for this difficulty is that different kinds of tumors in the chest can grow in such a way as to produce very similar roentgenologic signs. While, in most cases, Hodgkin's disease or lymphosarcoma involves nodes in both sides of the mediastinum and, consequently, produces a bilateral shadow which usually is nodular, lobular and more or less typical, it is not rare for these conditions to involve the nodes in one side much more than those in the other side; or even, as far as roentgenologic appearances go, the involvement may appear to be confined to the nodes in one side of this region. Sometimes, either in their original form or by some of the peculiar vagaries which may arise during their course, these forms of lymphoblastoma can simulate many other malignant neoplasms as well as some inflammatory conditions.

Involvement of thoracic wall: Hodgkin's disease or lymphosarcoma sometimes invades the chest wall, but usually, when this occurs, the involvement is secondary and not primary. Thus, in a few cases, a mass may slowly form in the subcutaneous tissues over the upper part of the sternum, usually at the level of the junction of the manubrium and the body of the bone. As a rule the greatest bulk of the mass lies slightly to one side or the other of the median line. When left untreated, the tumor gradually increases until it forms a mass the size of a fist, or even of two fists. When a surgeon ventures to explore such a tumor, he usually finds that it extends, in depth, through the inner part of one or more intercostal spaces adjacent to the sternum and is part of a similar process in the anterior mediastinum. In other words, it is an outward extension of a malignant lymphoid process in the anterior mediastinal nodes. Seldom are the ribs or sternum themselves affected, but occasionally the sternum may be eroded by the slowly increasing pressure of enlarging mediastinal nodes.

In a few cases, when the malignant process has advanced considerably, nodules appear in the skin or immediately beneath it;

nodules of this kind may develop in any part of the body. At first the color of the overlying skin is normal but, as the nodular infiltration progresses, the skin over the nodules slowly assumes a reddish hue, and later this reddish hue turns to a dull, beef-red color. Sometimes only a few nodules may be scattered irregularly, but sometimes the trunk or extremities may be studded with them.

From time to time a case is encountered in which the patient has discovered a lump or mass in the outer half of a breast. Because of its situation and because lymph nodes in the axilla may be abnormally large, the condition may be regarded as carcinoma, and a radical amputation of the breast may be performed on this assumption. But when a pathologist examines sections of the mass or of some of the axillary nodes, he finds Hodgkin's disease or lymphosarcoma. What probably had occurred was that some of the nodes in the axilla had first been affected, and later the malignant lymphoid process had extended to an aberrant node in the outer half of the breast.

In all but a small proportion of cases, Hodgkin's disease or lymphosarcoma remains confined within the affected lymph nodes, the size and number of which may increase more or less. But in a small proportion of cases, when the pathologic process reaches an advanced stage, the process may perforate the capsule of one or more nodes and may then infiltrate the surrounding tissues diffusely. Thus, when the nodes in one axilla are involved, the lymphoblastoma may infiltrate diffusely the entire axillary space, the side of the chest or even the breast.

Intrathoracic involvement: Most commonly, when the intrathoracic structures are invaded by these forms of lymphoblastoma, the condition begins in the mediastinal nodes, but only in a small proportion of cases does involvement of these nodes represent the primary lesion; in most cases it represents extension from the cervical or retro-abdominal nodes. In a few cases, however, Hodgkin's disease or lymphosarcoma, which may have been active in the abdominal para-aortic nodes for a long time, may extend through the diaphragm and may invade the pleural lymphatics over the thoracic surface of the diaphragm.

Involvement of mediastinal nodes begins in one node and gradually extends to other nodes, and the number and size of the affected nodes tends slowly to increase. In the majority of cases the nodes in the upper half of the mediastinum are mainly affected, but in a small number of cases the major involvement may affect nodes in the upper part of this region, at or just below the inlet of the thorax, or it may principally affect nodes in the lower half of the mediastinum. Usually, as the affected nodes continue to enlarge, they project laterally toward and into the

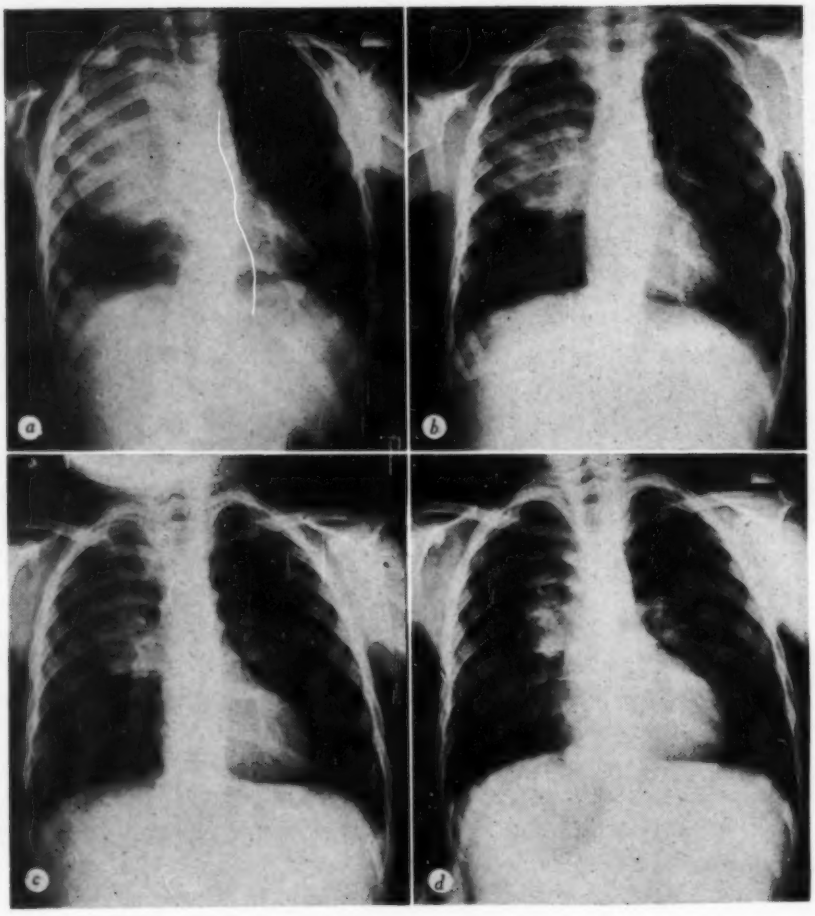


Figure 1: Roentgenograms of the chest in case 1.

Fig. 1a: Roentgenogram made on December 3, 1941. It shows an enormous tumor occupying the upper two thirds of the space ordinarily occupied by the right lung. Clinically or roentgenologically, it would be impossible to know which of several kinds of tumor this could be.—*Fig. 1b:* Roentgenogram made on December 22, 1941, three weeks after a course of roentgen treatment. It shows marked regression of the tumor. This rapid regression clearly indicated that the growth was a manifestation of lymphoblastoma (Hodgkin's disease or lymphosarcoma) and that it could not be a carcinoma, fibrosarcoma, neurofibroma, dermoid, teratoma or Pancoast tumor.—*Fig. 1c:* Roentgenogram made on December 26, 1941, without further treatment. It shows still greater regression of the tumor and this strongly confirms the previous conclusion.—*Fig. 1d:* Roentgenogram made on January 12, 1942, without additional treatment. It shows marked regression of the tumor which was then only a small fraction of its original size. A tumor derived from epithelial, connective or nerve tissue, or a teratoma, could never be influenced so rapidly and so much by roentgen rays. In this case, the rate of regression was somewhat more rapid than in the average case of mediastinal lymphoblastoma.

hilus of the lungs, but sometimes the nodes principally involved are in the anterior part of the mediastinum, and they may or may not be visible in roentgenograms. It is important to remember that, for lymph nodes to project laterally beyond the composite shadow cast by the sternum and spinal column, they must be rather large or numerous. Sometimes mediastinal nodes that are not large enough to be seen in roentgenograms may nevertheless cause symptoms, such as cough, or pain around one or both shoulders or in one or both of the upper extremities. Roentgen treatment directed toward the mediastinum through two large anterior and two corresponding posterior fields often causes these symptoms to abate rapidly or to disappear.

When Hodgkin's disease or lymphosarcoma involves the mediastinal nodes a roentgenogram of the thorax usually reveals a bilateral and roughly parallel widening of the shadow projected by the mediastinal structures, which extends from the suprasternal notch downward to the cardiac shadow which it overlaps more or less. This shadow is cast by affected right and left paratracheal nodes. In many cases the tracheobronchial nodes also are involved more or less extensively, and they cast an irregularly nodular shadow which projects outward beyond the vertical and parallel shadow produced by the paratracheal nodes. But in other cases roentgenography may not reveal this "typical" appearance, but may disclose a small or large tumor apparently confined in one side of the chest. Often this is situated in the upper part of the chest, where it may occupy space ordinarily taken by a portion of the upper lobe of one lung, or by all of it (Fig. 1). The tumor may be round and sharply circumscribed; it may be irregular and may have ill-defined and feathery margins, or it may have the form of a bird's wing, and its appearance may suggest extension upward and outward from the mediastinum. Certainly there is nothing characteristic about it and the tumor could as readily be carcinoma, fibrosarcoma or some other malignant growth, as Hodgkin's disease or lymphosarcoma. Besides the foregoing, other unusual forms may be observed in different cases.

Sometimes, besides more or less definite involvement of mediastinal nodes, an abnormal shadow may extend outward between two lobes of one lung as far as the periphery; this may be caused by infiltration of the interlobar pleura and, if so, roentgen treatment should cause it as well as the affected nodes of the mediastinum to diminish or disappear.

Occasionally, the nodes chiefly involved are high in the mediastinum (Fig. 2) and the symptoms may include not only dyspnea, with or without dysphagia, but also a brassy cough, hoarseness from involvement of one or both recurrent laryngeal nerves, puf-

finess and cyanosis of the neck and face and prominence of the superficial veins due to venous obstruction at or near the inlet of the thorax. Pressure may also be exerted on the trachea which may be displaced more or less, and this may be accompanied by increasing dyspnea and cough and by an expression of anxiety. The cervical nodes also may be abnormally large but, owing to the puffiness and engorgement, they may be difficult to perceive with certainty. A physician who is "thyroid conscious" may think that the roentgenogram suggests substernal extension of the thyroid (Fig. 3), but well-planned treatment, if given before these disturbances have been present too long, can often relieve them, at least for a time. For some obscure reason, when the lymph nodes in this part of the mediastinum are mainly affected, they are not influenced as rapidly by treatment as when the greatest involvement affects nodes lower in the mediastinum, and the degree of regression induced by treatment is often much less. Moreover, at necropsy, the affected nodes in this region often

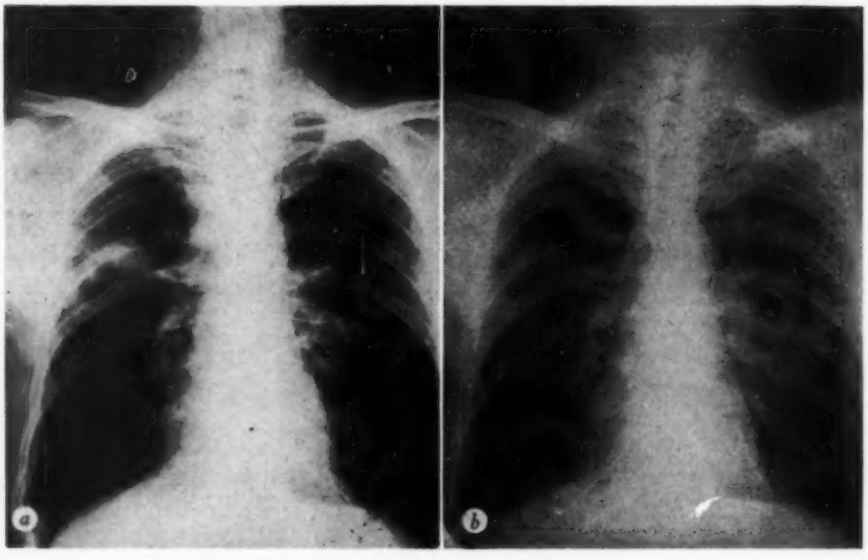


Figure 2: Roentgenograms of the chest in case 2.

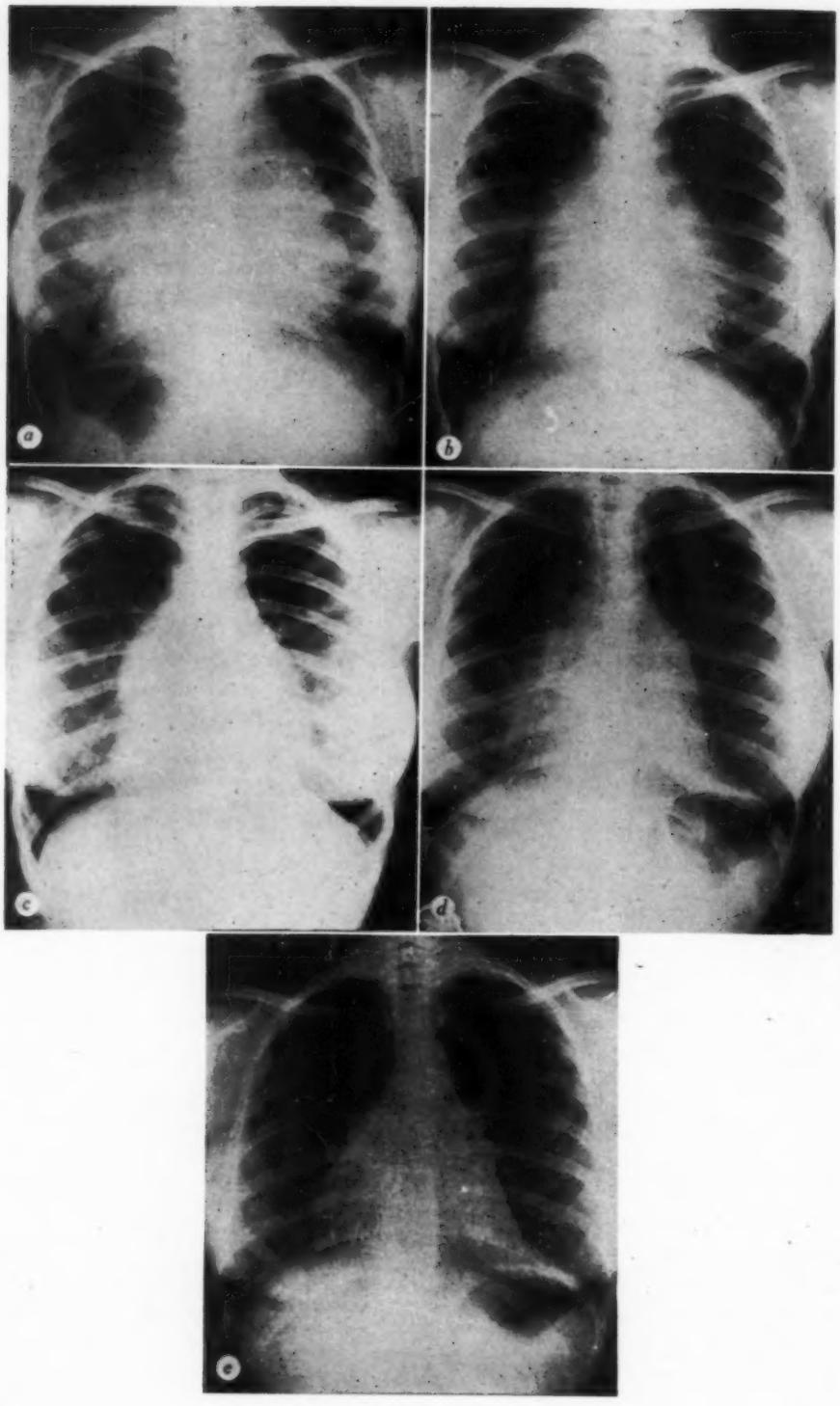
Fig. 1a: Roentgenogram made on January 31, 1945. It shows some widening of the upper part of the mediastinal shadow and an unusual lesion in the posterior peripheral portion of the parenchyma of the right lung, at the level of the sixth and seventh ribs. This lesion was thought to be tuberculosis. The patient's head, face and neck had become engorged (puffy) and cyanotic, the superficial veins of the anterior wall of the chest and abdomen had become prominent, he had become progressively weaker and his weight had diminished 14 pounds (6.4 kg.) in six weeks. Enlarged lymph nodes were present in both sides of the neck and in both armpits.—*Fig. 1b:* Roentgenogram made on March 12, 1945, after a single course of roentgen treatment. It shows considerable reduction in the width of the mediastinal shadow and in the area of interlobar infiltration in the right lung. The venous engorgement and cyanosis of the head, face and neck had disappeared and the patient felt and appeared to be much better.

contain an unusual proportion of connective tissue cells. It is not clear why, under these circumstances, the nodes should contain an exceptional proportion of connective tissue cells. A possible explanation might be the passive congestion resulting from pressure on the veins, but this is only conjecture.

In some cases of mediastinal lymphoblastoma, roentgenograms of the chest show little, if any, widening of the mediastinal shadow, and yet the symptoms suggest more or less definite involvement of the tracheobronchial nodes in and around the angle of the tracheal bifurcation. The reason the roentgenograms do not show lateral projection beyond the edges of the composite shadow cast by the sternum and spinal column may be that the affected lymph nodes have an anteroposterior disposition. In any event, exposure to roentgen rays through two anterior and two posterior fields, with the four beams of rays converging sharply on the mediastinal structures, is often as effective as in cases in which the anatomic disposition of the affected nodes is more orthodox.

Sometimes, a patient complains of pain in the chest or around one or both shoulders, or the pain may extend to one or both of the upper extremities. Occasionally, the pain may be confined to the extremities, and the patient may not have pain in the chest. Roentgenograms may show obvious or even marked involvement of mediastinal nodes, but in some instances evidence of mediastinal involvement may be slight or actually uncertain. Under these circumstances, it is important to exclude, by careful examination, the possibility that the pain may be due to pressure irritation or actual infiltration of branches of the brachial plexus on one or both sides by lymphoblastoma affecting some of the cervical nodes or by nodes in the upper part of the axillary (infraclavicular) space. When this possibility can be excluded, the treatment should be directed toward the mediastinum, as I have already suggested.

In lymphoblastoma, pleural effusion may be caused by obstruction of the inferior vena cava by enlarged nodes in the lower part of the mediastinum; because the adenopathy is concealed by the cardiac shadow, it may not be visible in ordinary roentgenograms, but its presence may be revealed by roentgenograms made by the method of Bucky. The effusion also may be due to infiltration of the pleura. In cases of this kind, effective irradiation requires that the fields be large enough to include the lower two thirds of the mediastinum as well as the entire diaphragm. Involvement of this kind, however, usually occurs only when the pathologic process has reached a relatively advanced stage, and prolonged improvement can hardly be expected under these circumstances.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Rarely, Hodgkin's disease or lymphosarcoma may infiltrate the lungs in what approximates a miliary manner or it may have the appearance of a falling, wet snow. That is, the infiltration is scattered more or less uniformly throughout the lungs and may readily be confused with metastasis from carcinoma or with some forms of tuberculosis. Infiltration of this kind indicates that lymphoblastoma has invaded most or all of the small aggregations of lymphoid cells situated at the junction of the smaller branches of the bronchi. This also is a relatively late complication. Nevertheless, thorough treatment may result in pronounced improvement, the duration of which may vary greatly in different cases.

In a small proportion of cases, Hodgkin's disease or lymphosarcoma, instead of affecting chiefly nodes in the anterior or middle part of the mediastinum, involves mainly nodes in the posterior mediastinum, and as the affected nodes continue to enlarge, one of two things may occur: either the enlarging nodes cause pressure on adjacent vertebrae and destructive erosion of some of these bones occurs, or the pathologic process may infiltrate an intervertebral space and thence may extend into the spinal canal, where it may even invade the spinal cord. When roentgenograms of the spinal column reveal destructive changes in one or more vertebrae, this is often assumed to represent metastasis from carcinoma, even when a primary tumor in some epithelial structure cannot be found, when the patient is rather young to be afflicted with carcinoma, when his general condition is altogether too good considering the character and duration of

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Figure 3: Roentgenograms of thorax in case 3.

Fig. 3a: Roentgenogram made on July 31, 1944. It shows an enormous intrathoracic tumor with bilateral involvement and with an outward projection toward the periphery on the right side. Besides the intrathoracic tumor, the neck was enormously and diffusely enlarged; the enlargement was smooth and soft and gave the impression that a large volume of air had been injected beneath the skin. This enlargement of the neck was not caused by air, but by distention and engorgement of veins from pressure on the great vessels just below the thoracic inlet and by enlargement of cervical lymph nodes.—*Fig. 3b:* Roentgenogram made on November 14, 1944, after two courses of roentgen treatment, part of which was directed toward the chest and part of it toward the neck. During and after the first course of treatment, the size of the intrathoracic tumor as well as the enlargement of the neck diminished steadily. The patient's condition improved rapidly, and the malignant process continued to retrogress after the second and third courses of treatment. By that time the enlargement of the neck as well as the cough and dyspnea had disappeared, the patient's weight had increased six pounds (2.7 kg.) and she looked much better.—*Fig. 3c:* Roentgenogram made on January 22, 1945, after three courses of roentgen treatment. It shows marked, but still incomplete, regression of the intrathoracic tumor.—*Fig. 3d:* Roentgenogram made on April 4, 1945. It shows still greater regression, but on the right side at the level of the hilus there is evidence of fresh enlargement of lymph nodes. On this account a fourth course of treatment was given.—*Fig. 3e:* Roentgenogram made on May 21, 1945. It shows still greater regression of the intrathoracic tumor. The patient was entirely free from symptoms and may remain so for an indefinite period.

his illness and when enlarged nodes in other regions would hardly be consistent with a diagnosis of carcinoma or epithelioma.

TREATMENT

When a thoracic or intrathoracic tumor is suspected of representing Hodgkin's disease or lymphosarcoma, this suspicion can often be confirmed or excluded. Since tumors of this kind are largely composed of hyperplastic lymphoid cells, they are usually very sensitive to roentgen rays, a sufficient dose of which causes the tumor or tumors to retrogress rapidly. The rate and degree of regression vary to some extent in different cases, and this variation is undoubtedly related to histopathologic differences in the affected lymphoid structures. Nevertheless, in the majority of cases a lymphoblastomatous tumor in the mediastinum or chest can be expected to shrink from 30 to 100 per cent within three or four weeks after a well-planned course of treatment. Naturally, the degree of regression in each case depends on the size of the enlarged nodes before treatment.

In some cases the first course of treatment may not cause the tumor to diminish more than 25 per cent; as I have already mentioned, this may be due to the presence in the tumor of an exceptional proportion of connective tissue, which prevents the growth from being influenced as much as it would be otherwise. Another element which may diminish the effect of the rays is the association in the affected mediastinal nodes of Hodgkin's disease or lymphosarcoma and tuberculosis, but this association occurs only in a small percentage of cases. A third factor which may prevent enlarged lymph nodes in the mediastinum or elsewhere from being influenced by the rays as much as would usually be expected is related to the stage of the pathologic process. When the malignant process has reached an advanced stage or has entered the terminal phase, when several groups of nodes in different parts of the body, and especially the retro-abdominal (paraaortic, mesenteric or iliac) and mediastinal nodes are extensively involved, and when the patient's general condition has deteriorated considerably, the influence of the rays may diminish and the affected lymphoid structures may respond less than usual or may not respond at all. This varies more or less in different cases, but the general rule holds.

Sometimes a patient may appear to be quite ill and may have severe dyspnea or orthopnea, severe cough, a rapid pulse, and one or both pleural cavities may contain a considerable amount of fluid; yet well-planned treatment may still be accompanied and followed by rapid and marked improvement. This is especially true when the nodes in other regions are not greatly involved,

but it may be true even when they are; under these circumstances, however, the degree of improvement is not likely to be so great or to last so long.

Anatomic arrangement of the treatment: Whether the treatment is given to distinguish one variety of tumor from another variety, or whether it is given purely for its therapeutic effect, it should be arranged in the same manner, and this arrangement depends mainly on the situation of the affected structures and on the predominating symptoms.

In the majority of cases in which the mediastinal lymph nodes are involved, treatment should best be arranged through two large anterior and two corresponding posterior fields, as shown in figure 4. How large the fields should be depends on the size of the patient. Vertically the fields should extend from the level of the suprasternal notch down to the level of the ensiform cartilage. Horizontally, or transversely, they should extend from the median line to the anterior axillary line. The four beams of rays should be directed toward the central part of the chest at an angle of 30 or 40 degrees. When, as is commonly done, treatment is arranged through only two fields (one anterior and one posterior), its effect is much less favorable. This is not surprising, because, with the former arrangement (two anterior and two posterior fields), the quantity of rays reaching the mediastinal structures and the inner portion of the lungs is twice as great (or nearly so) as when treatment is given through only two fields (one anterior and one posterior).

When the nodes principally affected are in the upper part of

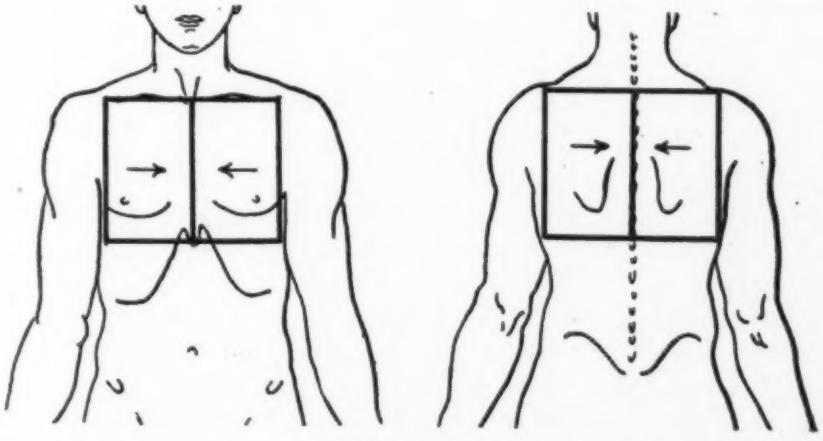

Fig. 4: Arrangement of fields for treatment of the mediastinum and lungs. The arrows indicate that the four beams should be directed inward more or less according to whether the treatment is directed only toward the mediastinal structures and inner part of the lungs or is directed toward the mediastinum and greater part of the lungs.

the chest, just below or in the inlet of the thorax, and when the symptoms and physical signs indicate pressure on the superior vena cava and innominate veins, whether or not the deep cervical nodes also are involved, treatment should be directed toward the mediastinum in the manner which has been described, but it should also be directed toward the thoracic inlet and lower half of the neck through two additional fields, as shown in figure

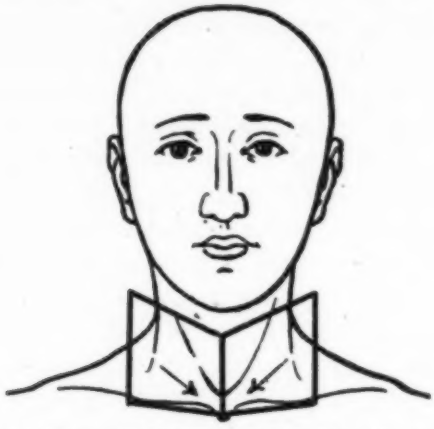

Fig. 5: Arrangement of fields when, besides the mediastinum, the inlet of the thorax and lower part of the neck also should be treated. The arrows indicate that the two beams of rays should be directed inward and downward toward the thoracic inlet.

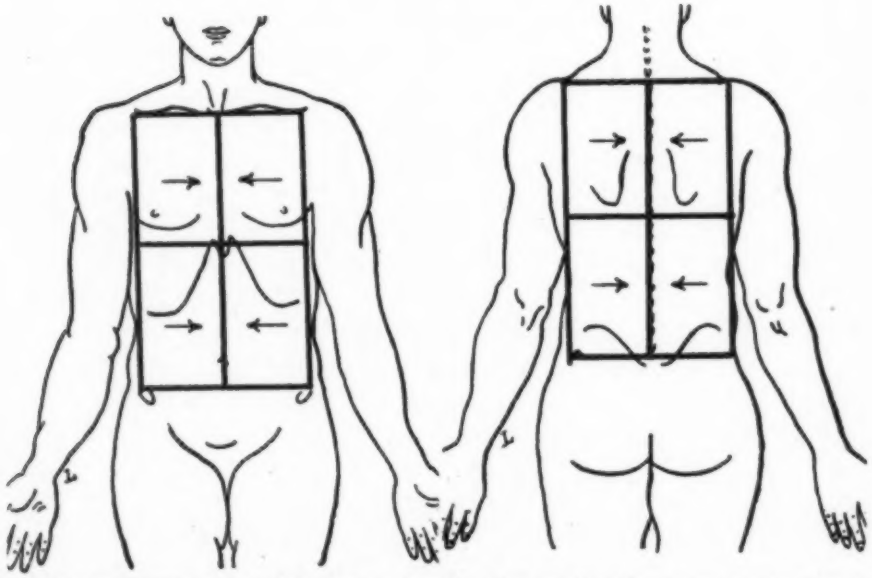

Fig. 6: Arrangement of fields when, besides the mediastinum and central part of the lungs, treatment should also be directed toward the upper half or two thirds of the abdomen. The arrows indicate that all the beams of rays should be directed inward and backward (anterior fields) or inward and forward (posterior fields).

5. And when, besides involvement of mediastinal nodes or lungs, the retro-abdominal nodes also are affected, additional treatment should be directed either toward the upper half of the abdomen through two anterior and two posterior fields (Fig. 6) or toward the entire abdomen through four anterior and two of four posterior fields (Fig. 7), according to circumstances.

Quality of the rays: For some years it has been a sort of fashion to treat all kinds of malignant tumors with rays generated at 200, 400, 600 or even 1,000 kilovolts and filtered through 0.5, 0.75, 1.0 or 2.0 millimeters of copper, or even more, and to administer treatment by the so-called fractional method, with as large a total dose as possible. This idea sprang from the results of experiments on animals performed by Regaud and his co-workers,[22-34] and by others; these experiments had shown that, when living tissue is exposed to roentgen rays in small, fractional doses, a much larger total dose can be given without producing serious damage than when the same tissue is exposed to a single dose at one time. The experiments of Wood and Prime[35] in this country had shown that, in order to stop the growth of epithelial tumors, a total dose of rays from five to eight times the limit of tolerance of any given area of skin is required. Since the only safe way in which such a dose can be given is by dividing it into small fractions which are given twice or once a day, or every other day, this method of treating malignant tumors has been widely adopted and is applied almost indiscriminately to tumors of all kinds.

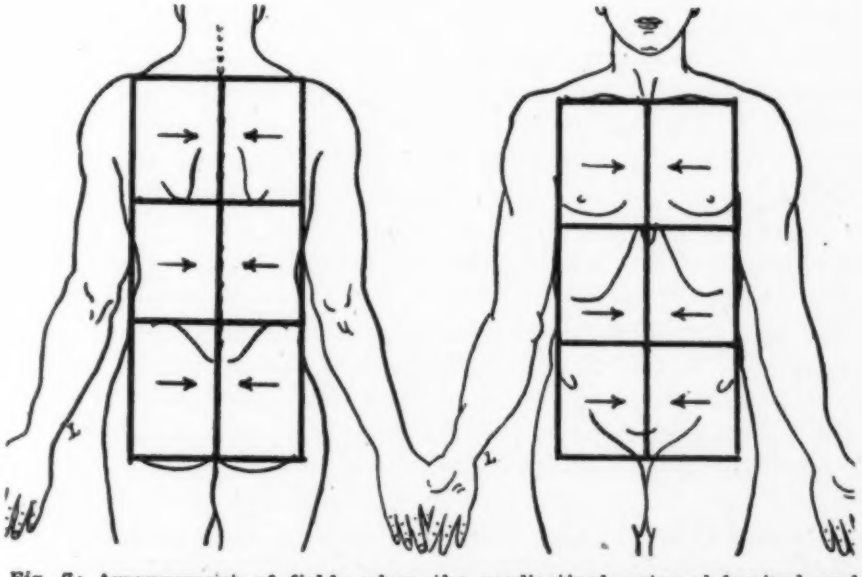

Fig. 7: Arrangement of fields when the mediastinal, retro-abdominal and iliac lymph nodes must all be treated.

Other factors which have influenced many to "standardize" treatment in this manner have been the trend toward greater and greater "depth doses" obtained by increasing voltage and filtration and the conception that the effect of the rays does not vary with the voltage, but only with the quantity (number of roentgens) delivered to the tumor.

But methods which may be entirely rational when employed in the treatment of epithelial neoplasms or of tumors which have an equal or greater resistance to roentgen rays may not be so effective when applied to tumors which are much more sensitive to the rays. I have already pointed out how extremely sensitive are lymphocytes, or lymphoid cells, in comparison with epithelial cells; this difference is so great that many physicians find it difficult to believe. A dose of 10 roentgens is sufficient to destroy a small proportion of lymphoid cells in a lymph node, and a dose of 100 roentgens causes greater destruction of these cells, whereas about 600 roentgens of rays generated at the same voltage are required to destroy a perceptible number of epithelial cells in the skin.

For many years, as far as treatment of Hodgkin's disease or lymphosarcoma is concerned, I have observed that rays generated at 200 kilovolts or more and filtered through 0.5, 0.75, 1.0 or 2.0 millimeters of copper (or through an equivalent thickness of zinc) are not as effective as is a corresponding dose of rays generated at 130 or 140 kilovolts and filtered through 4.0 or 6.0 millimeters of aluminum. Some years ago, comparative tests of treatment with rays produced at these two ranges of voltage gave results which were clearly in favor of the lower voltage, and subsequent experience has amply confirmed the results of those tests. How can this difference be explained? The only explanation I can think of is that, when the rays are generated at 200 kilovolts or more, a considerable proportion of the rays pass through the exposed region without being absorbed and, therefore, without producing any cellular effects, but when the rays are generated at moderate voltage (130 to 140 kilovolts), a larger proportion of them are absorbed by the cells in the exposed territory. In my experience, treatment at moderate voltage is more effective, both immediately and for the long run, than treatment at high voltage.

Quantity of rays: Because, in epithelial and other resistant tumors, effective destruction of the malignant cells requires the largest dose of rays which can be given with safety, it is widely assumed that the same is true of all malignant processes. When lymphoblastoma is limited to a single region, and especially when it is confined to a small cluster of nodes, the hope of permanent cure may reasonably be entertained and a complete result can

rarely be achieved, but this is never true when the pathologic process involves the mediastinal nodes or other thoracic structures. Under these circumstances, complete and permanent regression of the lymphoblastomatous lesions is practically out of the question; the most that can be expected is marked regression and prolonged remission. In most cases, therefore, the aim should be to obtain maximal improvement and to maintain this improvement as long as possible. This can seldom be achieved with rays generated at high voltage, with maximal doses given by the fractional method. To follow this course may yield excellent initial results, and treatment may be repeated at long intervals once or twice at most, but when the pathologic process again becomes active, as it inevitably does, further treatment is impossible or, if it is undertaken, it has little, if any, effect and the patient no longer can obtain relief.

Sometimes treatment is given with rays generated at high voltage (200 kilovolts or more), but the surface dose given to each field does not exceed 600 roentgens, and this dose is divided into daily fractions of 100 or 200 roentgens. This is more effective than the fractional method with a maximal total dose, but a still more effective method is to employ rays generated at 130 or 140 kilovolts and filtered through 6 millimeters of aluminum, and to give to each field a surface dose of 550 roentgens at one time (on one day); when the patient cannot tolerate 550 roentgens in one session, half of this dose may be given on one day and half the next. Then the other fields should be similarly treated in rotation and as rapidly as the patient's tolerance allows. Thus, when the chest alone requires treatment, the four fields (each receiving 550 roentgens) can usually be irradiated in four successive days. Irradiation of the chest seldom causes marked radiation sickness. But when, besides the chest, the upper half of the abdomen or the entire abdomen must also be treated, the course of treatment consumes much more time and may require from eight to sixteen days, according to the patient's tolerance.

As I have already indicated, a single course of treatment such as has been outlined, when given to a patient who had never been treated before, may be expected to cause the affected lymph nodes to retrogress from 25 to 100 per cent in three weeks. But even when the treatment is followed by what may appear to be 100 per cent regression, it is almost always wise to give a second course of similar treatment three weeks later, provided the number of leukocytes in the blood has not diminished too much. The reason for repeating the treatment is that it causes the regression and improvement to last much longer than would be likely to happen after a single course of treatment. In cases in which the initial

involvement is rather marked it is often wise to give three courses of treatment, but the interval between the second and third courses may be increased to five or six weeks.

Subsequently the patient should be examined at regular intervals; for the first year this may be once in three months, but, when signs of fresh activity of the pathologic process in the lymph nodes do not appear during this period, the intervals may be increased to four or even six months. Sometimes the improvement may continue for several weeks or several months, and sometimes it may continue for two, three or more years; this varies greatly in different cases and depends mainly on whether the patient is afflicted with Hodgkin's disease or lymphosarcoma in a relatively acute or subacute form, or whether the process has a relatively chronic form. If, when the patient is first seen and treated, the malignant condition has not advanced too much and is not too extensive, and if he is fortunate enough to have the chronic form, he may survive for several or even for many years. He will probably need treatment from time to time, but the affected lymph nodes will continue to respond well.

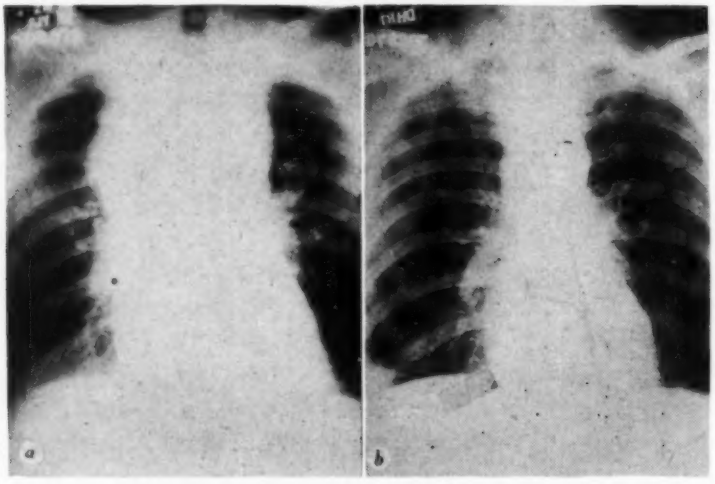

Fig. 8: Roentgenograms of thorax in case 4.

Fig. 8a: Roentgenogram made on September 24, 1930, showing marked enlargement of mediastinal nodes. The patient was a young man, twenty-six years of age, who had been ill only six months. The cervical nodes were greatly enlarged, and the face and neck were engorged and cyanotic from venous obstruction. The retro-abdominal, axillary and inguinal also were extensively involved. The patient was pale and weak but his weight had not diminished.—*Fig. 8b:* Roentgenogram made on October 1, 1930, after roentgen treatment each day for six days. It shows extremely rapid and marked regression of the affected mediastinal nodes. This indicates great instability of the lymphoid system; when the lymph nodes are involved as extensively as this and when they retrogress as rapidly as they did in this case, the patient seldom can be expected to live long. In this case the patient died eight months later.

When, as is sometimes done, treatment is given only once or twice a week, the patient does not improve as rapidly or as much as he should; and when the quantitative dose of rays given to each field, whether this is done at one time or by the fractional method, is excessive, the affected lymphoid structures rapidly become resistant to the rays, and thenceforth the treatment becomes less and less effective. When excessive doses are avoided, the affected structures continue to respond indefinitely. It is true that, as time goes on, especially in the chronic form of lymphoblastoma, some increase in resistance of the lymphoid cells develops, but this is slow. In most cases, gradual failure of lymphoblastomatous lesions to respond to irradiation is due to (1) an advanced stage or terminal phase of the pathologic process and (2) excessive quantitative doses of rays within a given time.

PROGNOSIS

Survival depends chiefly on the three following factors: (1) the relative acuteness or chronicity of the malignant lymphoid process; (2) the extent of involvement and the stage which the condition has reached when it is recognized and when treatment is started and (3) the thoroughness and care with which the treatment is planned and given. Of these three factors the first two are much more important than the third, and the first is more important than the second. It must not be inferred that treatment is of small consequence; it is true that, in the average case, its influence on survival is not as great as might be desired (Fig. 8), but there is no doubt that, when patients receive sound treatment, their condition is much better and their symptoms can be kept under partial or complete control for long periods.

In cases of relatively acute lymphoblastoma the pathologic process runs a comparatively short course, and the time which elapses between the apparent onset of the disease and the death of the patient may vary between six months and three years; fortunately, the number of cases in this group is small. By far the largest group consists of patients who are afflicted with these conditions in a relatively subacute form, in which the course of the process extends from three to six years (Fig. 9). In a considerable number of cases the patients have the chronic form, in which the malignant condition may continue from six to ten, fifteen or twenty years, or even longer.

SUMMARY

Each variety of normal cell has a specific range of sensitiveness to roentgen rays. The different varieties of normal cells are listed in the order of their sensitiveness. The action of roentgen rays on

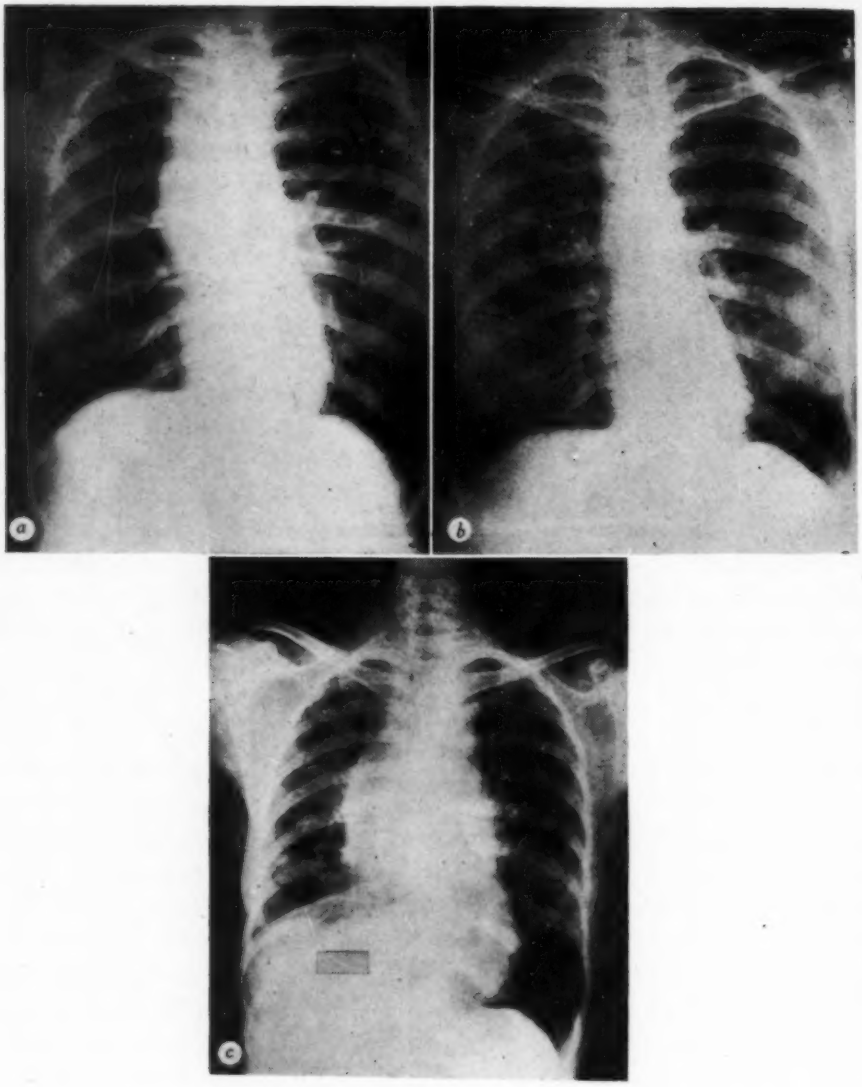

Fig. 9: Roentgenograms of the chest in case 5.

Fig. 9a: Roentgenogram made on July 29, 1921. It shows moderate enlargement of mediastinal nodes, principally on the right side. Besides this, some nodes in the neck, armpits and groins also were affected.—*Fig. 9b:* Roentgenogram made on September 28, 1921, after a course of roentgen treatment. It shows marked regression of the mediastinal nodes, and the cervical, axillary and inguinal nodes also had been correspondingly influenced by the treatment. Then the patient remained well and free from symptoms and lymphadenopathy until 1927.—*Fig. 9c:* Roentgenogram made on June 6, 1927. It shows fresh and considerable enlargement of mediastinal nodes. Roentgen treatment again caused these nodes to retrogress markedly. Then the patient was well until 1932 when weakness, pallor and gastro-intestinal symptoms developed and physical signs indicated probable involvement of retroperitoneal nodes. The cervical, axillary and inguinal nodes also had again enlarged. Roentgen treatment directed toward the upper two thirds of the abdomen and toward the chest was followed by substantial improvement

cells is briefly described, lymphocytes being used as an example. Then the sensitiveness of different kinds of tumors is mentioned, and stress is laid on the close correspondence in sensitiveness between tumors and the normal cells from which different kinds of tumors are derived. Knowledge of the relative sensitiveness of different tumors often permits one to distinguish some tumors from others, and this is as true of thoracic and intrathoracic tumors as it is of tumors in general.

The more common clinical and roentgenologic features of Hodgkin's disease or lymphosarcoma of the chest are reviewed. Then the treatment of these conditions is discussed with reference to the anatomic arrangement of the fields, the quality and quantity of the rays. Finally, the principal factors which govern prognosis are mentioned.

RESUMEN

Cada variedad de célula normal tiene una esfera específica de sensibilidad a los rayos de Roentgen. Se cataloga las diferentes variedades de células normales en el orden de su sensibilidad. Se describe brevemente la acción de los rayos de Roentgen sobre las células, usando los linfocitos como ejemplo. Se menciona después la sensibilidad de diferentes clases de tumores, y se hace hincapié sobre la íntima correspondencia en sensibilidad que existe entre los tumores y las células normales de las que se derivan diferentes clases de tumores. El conocimiento de la relativa sensibilidad de diferentes tumores frecuentemente nos permite distinguir unos tumores de otros, y esto es tan cierto en tumores torácicos e intratorácicos como lo es en tumores en general.

Se repasa los rasgos clínicos y roentgenológicos más comunes de la enfermedad de Hodgkin o linfosarcoma del pecho. Se discute después el tratamiento de estos estados con respecto de la disposición anatómica de los campos y la calidad y cantidad de los rayos. Finalmente, se menciona los principales factores que determinan el pronóstico.

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Length and Width Changes in the Pulmonary Arterial System of Rabbits in Passing from the Stage of Expiration to that of Collapse as Revealed by Roentgenography

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Macklin[1] has recently re-opened the discussion of functional length and width changes of the pulmonary vasculature in respiration, and has advanced the view that, particularly when ventilation is vigorous, these changes are marked in the arteries and veins. In passing from the inspiratory to the expiratory phase there is a decrease in the length and width of both arteries and veins, and there is a corresponding increase in going from expiration to inspiration. He finds that there is a periodic respiratory decrease and increase in the volume of the arteries and veins in expiration and inspiration respectively, and feels that this volumetric change, rhythmically repeated, has the effect of a pump which aids the heart. The idea of a thoracic pumping action is, of course, not new, but the histophysiological approach to the problem enables it to be seen in a new light. There is much discussion in the original paper which cannot be gone into here.

The length and width changes in the pulmonary blood vessels in passing from the expiratory phase to that of collapse are of much the same order as those above-mentioned in that they are motivated largely by the action of the perivascular sheaths of air sacs; and an opportunity to study them briefly by roentgenography has recently been afforded. It is hoped to expand the data bearing on this and allied subjects in the near future.

MATERIAL AND METHOD

Two rabbits of approximately equal weight, five and one-half pounds, were selected. They were anesthetized and some seven cubic centimeters of a solution of 1 per cent of potassium oxalate and 4 per cent of sodium nitrite in distilled water were injected into the flowing blood, following which the abdominal aorta was cut. In one animal, R22, the rest of the experiment was done with the chest unopened, but in the other, R26, the diaphragm was nicked and the subsequent procedures took place with the lung in a state of collapse. The inferior vena cava was cannulated and

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into it was injected a solution of .4 per cent sodium nitrite and .5 per cent sodium chloride in water at a pressure of 6 inches, for R22 and 10 inches for R26. In this way the vessels of the lungs were flushed out via the heart. Immediately thereafter, there was injected, through the same cannula, a radio-opaque latex or artificial rubber. The latex was made opaque by the addition of thorotrast (Heyden Chemical Corporation, New York), 10 per cent in the case of R22 and 20 per cent in R26. It was found easy to inject the latex by simple manual pressure on a syringe. Although a pressure indicator was not used, the feeling was that it was about the same in the two cases. Fixation of the latex *in situ* was accomplished by introducing a solution of 5 per cent glacial acetic acid in 95 per cent ethyl alcohol into the trachea by means of a cannula attached by rubber tubing to a small funnel in which the level of the alcohol was about 6 inches above the lung. Bubbles were evacuated by gentle squeezing of the chest, and the inflow allowed to proceed slowly overnight. When the lungs were removed next morning they were fairly stiff, and held their shape. They were immersed for a further period in 95 per cent alcohol.

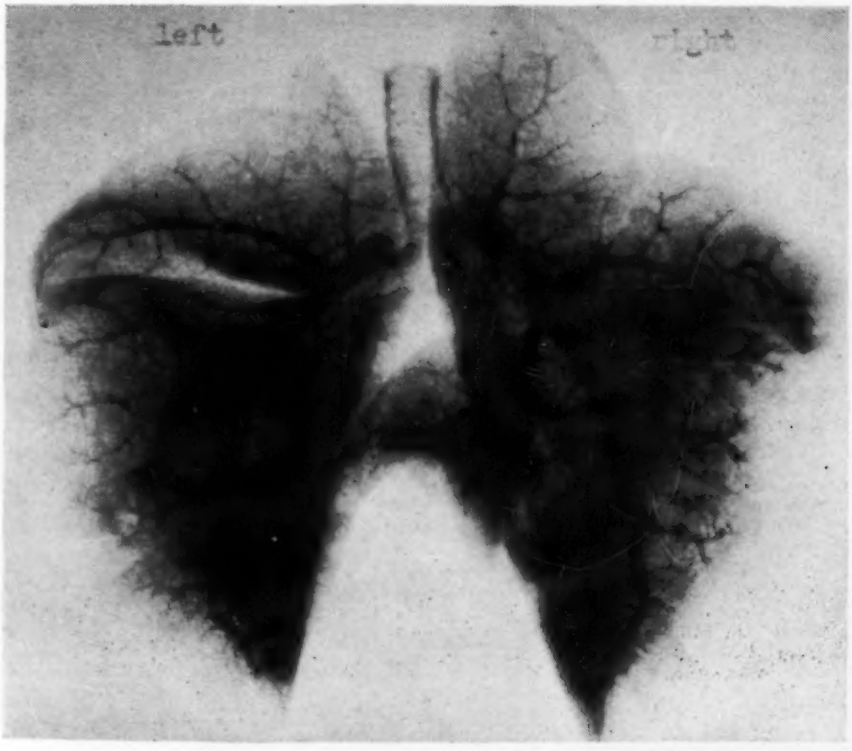

Fig. 1: Print from a radiograph of the lungs of a rabbit (S86-R22) in a state of moderate inflation, corresponding roughly to expiration. The arteries contain radio-opaque latex.

The heart, oesophagus and other extraneous tissues were removed and the two lungs, held together by their vessels and bronchi, and with lobes spread out, were radiographed by Dr. Leila Howell of the Victoria Hospital, London, X-ray staff, at a distance of 36 inches tube to table.

The results showed that the main branches of the pulmonary arteries, and even subsidiary branches, were much shorter and narrower in R26, representing collapse, than were the corresponding vessels in R22, representing expiration. This is, of course, what would be expected; for one cannot view two lungs from animals of approximately equal size, of the same species, the one inflated and the other collapsed, without realizing that the blood vessels (as well as the air channels) must be shortened in collapse, and since narrowing so frequently goes with shortening it would be natural to suppose that the collapsed lung would show narrower vessels. The radiographs, as seen in the figures illustrate these changes very strikingly (Figs. 1 and 2).

DESCRIPTION OF THE FIGURES

Figure 1 is from a print of a radiograph of rabbit S86-R22 taken on August 23rd, 1945, and Figure 2 is from a print of a radiograph of another rabbit, S86-R26. of approximately the same weight,

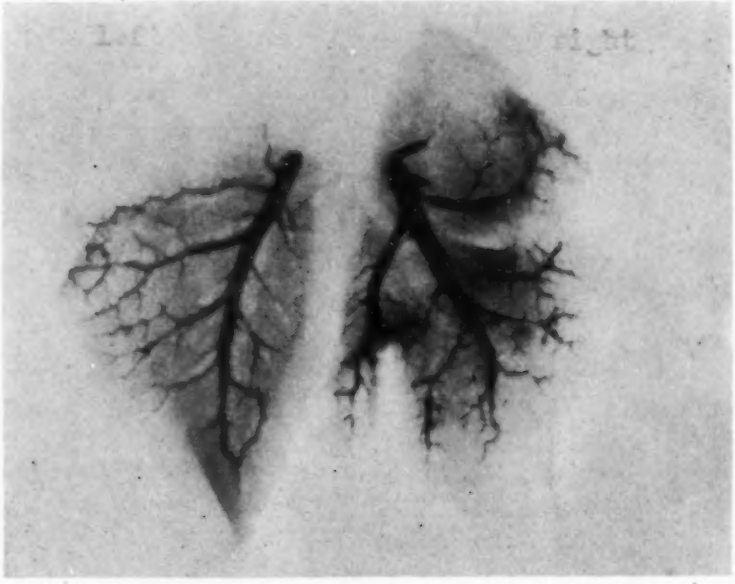

Fig. 2: Print from a radiograph of the collapsed lungs of a rabbit, (S86-R26). The arteries contain radio-opaque latex, but those of the upper lobes are unfilled. The shortening and narrowing of the vessels which are embedded in collapsed lung tissue are apparent from a comparison with figure 1.

taken on August 26th, 1945. Figure 1 shows the moderately expanded condition, and Figure 2 the collapsed condition. By comparing the measurements of the main blood vessels in the two films, as made by dividers and a centimeter scale, the following data were obtained:

LENGTH CHANGES

Left main trunk; distance between extremities, direct	R22 — 55 mm.
Left main trunk; distance between extremities, direct	R26 — 39 mm.
Difference, representing the shortening in passing from moderate expansion to collapse	16 mm.
Expressed as a percentage this value would be	29%
Right main trunk; distance between extremities, direct	R22 — 60 mm.
Right main trunk; distance between extremities, direct	R26 — 36 mm.
Difference, representing the shortening in passing from moderate expansion to collapse	24 mm.
Expressed as a percentage this value would be	40%
Averaging the two sets of measurements we find that the shortening of the two main trunks is	34.8%

WIDTH CHANGES

Left main trunk; width at the base	R22 — 3.5 mm.
Left main trunk; width at the base	R26 — 2.0 mm.
Difference, representing the narrowing in passing from moderate expansion to collapse	1.5 mm.
Expressed as a percentage this value would be	43%
Right main trunk; width at the base	R22 — 3.33 mm.
Right main trunk; width at the base	R26 — 2.33 mm.
Difference, representing the narrowing in passing from moderate expansion to collapse	1 mm
Expressed as a percentage this value would be	30%
Averaging the two sets of measurements we find that the narrowing of the two main trunks is	37%

These data on one animal cannot, of course, be considered as final, but in the nature of a preliminary statement. The findings, however, do bring home to us with no little emphasis how intimately bound up with the lung tissues are the two vascular trees, arterial and venous; and how the collapse of the lung is directly felt by these blood vessels not only by length changes (shortening) but also by width changes (narrowing). We realize that in inflating the lung tissue there must be a widening and

lengthening of the pulmonary arteries and veins associated with the region undergoing inflation; and that in deflating it there must be a corresponding narrowing and shortening of the same. Furthermore, it is apparent that such an action, repeated indefinately, as in strong exercise, cannot have other than a pumping action upon the blood which is traversing the pulmonary circuit, and that this action will be an aid to the heart. Indeed it may well be spoken of as the pulmonary accessory heart action. There is also, of course, in the systemic circulation, what may be called a systemic accessory heart action, and the two actions, particularly in young persons in vigorous exercise, combine to aid the heart in maintaining the circulation.

THE EFFECT OF A DIMINUTION OF THE STREAM BED OF A SINGLE COLLAPSED LUNG UPON THAT OF THE OTHER LUNG

It is obvious from the roentgenogram of the collapsed lung that in it the stream bed is diminished and the blood flow lessened. If this happens in the lung of one side, such as in unilateral pneumothorax, then there must be a compensatory enlargement of the stream bed in the lung of the opposite (functional) side if the circulation is to be maintained. This is provided for by compensatory alveolar ectasia (emphysema) of the functional side. Overinflation of this lung has the effect of lengthening and widening its arteries and veins by traction of the stroma (Macklin and Macklin[2]). Thus more blood goes through the functional lung in such a case than is usual for it under normal conditions. This lung is thus doubtless enabled to assume a greater physiological load to compensate for the respiratory loss entailed by the collapse of the other lung. There is another advantage, too, in the swelling of the pulmonary blood vessels, for if they did not do so, from increase in blood volume, there would be a tendency to the production of pulmonary interstitial emphysema because of the introduction of what has been spoken of as "Factor B" (Macklin and Macklin[2]). This factor consists in the failure of a pulmonary artery or vein to dilate when the surrounding alveolar tissue pulls away from it as it does when the air spaces around it are distended. In the event of such a failure there is a tendency for air to break from the alveoli into the perivascular connective tissue, and this results in interference with the circulation on account of pressure by bubbles of air upon the blood vessels. For an understanding of this condition reference must be made to the article above cited, and other articles in the bibliography which it contains. Similar, but more localized, examples of pulmonary vascular dilatation occur in regions of alveolar ectasia near those of atelectasis.

CONCLUSIONS

Roentgenography has provided evidence to show that the pulmonary arteries are shortened and narrowed in passing from the stage of expiration to that of collapse.

Reasoning from this finding, and with a picture of the histology of the lung before us, it is possible to understand better the action of the pulmonary vasculature and its environment of expanding and contracting air spaces in acting as an accessory heart.

Light is thrown, too, on the compensatory enlargement of functional capacity and on the protective reaction against the supervention of pulmonary interstitial emphysema which occur in the intact parts of a lung or parts thereof in the presence of extensive collapse of neighboring lung tissue.

I wish to thank the staff of the X-ray laboratories of Victoria Hospital, London, for their kind and efficient co-operation, and also Mr. Charles Jarvis for the photographic reproductions, and Mr. James Machan for assistance with the operations.

CONCLUSIONES

La roentgenografía ha suministrado pruebas que demuestran que las arterias pulmonares se acortan y se angostan cuando pasan del período de expiración al del colapso.

El raciocinio basado en este hallazgo, teniendo en cuenta el cuadro de la histología pulmonar, nos permite comprender mejor la función de corazón accesorio que desempeñan la red vascular pulmonar y los espacios aéreos circundantes con su dilatación y contracción sucesivas.

Se hace luz también sobre la hipertrofia compensatoria de la capacidad funcional y sobre la reacción que proteje contra la superveniencia de enfisema pulmonar intersticial, que tienen lugar en las áreas intactas de un pulmón, o partes de un pulmón, cuando existe colapso extenso de tejido pulmonar circunvecino.

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The Lateral Projection of the Chest

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One of the most important fundamental principles in roentgenography is the making of two projections at right angles of any part of the body to be examined. This method gives one a true three dimensional study of the part under investigation. The advantages of this procedure in the analysis of any abnormal changes are self-evident and it was naturally adopted in practically all x-ray examinations. In addition to the above there was also introduced the principle of stereoscopy, known as stereoroentgenography, which consists in taking two pictures from slightly different positions. When these are placed in a stereoscopic apparatus one obtains the perception of objects in relief.

The stereoscopic method of examination has achieved great popularity among roentgenologists and was accepted wholeheartedly by physicians and surgeons to the extent that it is now considered to be almost an act of heterodoxy on the part of anyone who expresses doubt as to its value. Without entering into a ful discussion of the merits or demerits of either method I will relate some facts in my own experience and will try to prove by several representative illustrations the superiority of the first method over the second in the great majority of chest examinations.

My first big opportunity to examine chests on a large scale was during the first World War. I found that stereoscopic views of the chest in the anteroposterior position alone added hardly any more information than that obtained from a single view. However, when the patient was examined fluoroscopically from every possible angle it was possible, in the presence of an abnormal shadow in the lung field, to determine more accurately its exact location, shape, size and relationship to the surrounding structures and its probable nature. It has also been found that some abnormal shadows are entirely obscured in the antero-posterior position because of their situation in the course of the cardiovascular shadow. These also are rendered accessible to sight in the oblique or lateral positions.

With the above experience before me the next logical step was to take roentgenograms in the lateral positions. Contrary to the general opinion, which is held by many roentgenologists, the technic is not difficult to acquire by the average technician. In my laboratory lateral views of the chest have been taken routinely

under all kinds of conditions by myself or my technicians with satisfactory results. The only necessary requisite is the application of common sense in x-ray technic. After twenty-five years, during which time the use of the lateral view of the chest was more or less ridiculed, it is indeed a great satisfaction to see that many more illustrations of the lateral view are found in the roentgen literature. This is obvious evidence that its value is finally being appreciated.

A number of cases have been chosen for a more or less detailed description illustrating lesions of the respiratory organs in the anterior and lateral positions. It is hoped that even a casual glance at the roentgenograms will convince any skeptically minded physician of the superior value of this technic in the study of chest affections.

Bronchiectasis usually involves the lower bronchial branches which are often obscured by the heart and diaphragm. The diaphragm, as will be recalled, is not on the same plane through its entire expansion, but gradually slopes down from before backwards and laterally, so that its posterior attachment is on a much lower level than the anterior. Under such conditions the lower region of the lung is more or less obscured when the chest is viewed in the anteroposterior direction, but when the same is observed laterally any changes affecting the pulmonary bases, bronchi, pleura and diaphragm may readily be seen.

CASE REPORTS

Case 1: The anterior view (Fig. 1A) shows nothing remarkable in the lung fields with the exception of calcified nodules in the hilar region. In the lateral view (Fig. 1B) there are noted several irregular dense shadows, some of which show horizontal fluid levels, located in the retrocardiac space above the posterior half of the diaphragm. The bronchial branches extending to the hilum are thickened. The diagnosis of bronchiectasis was later confirmed by the injection of lipiodol. The above recalls other cases of small pleuritic effusion and diaphragmatic pleurisies which were recognized in the lateral view although the anteroposterior view was apparently negative.

Calcified glands are frequently seen in the course of the trachea and bronchial tree in the anterior projection, but when they occupy a position within the boundaries of the cardiovascular shadow they usually escape notice. If this applies to such opaque shadows, it is even more true in the case of soft shadows when they happen to be in similar locations. It is quite obvious that their recognition is difficult and some other method must be used such as the lateral projection.

Case 2: The anterior view (Fig. 2A) show emphysematous lungs with a low diaphragm. No other abnormal changes are noted, however, in

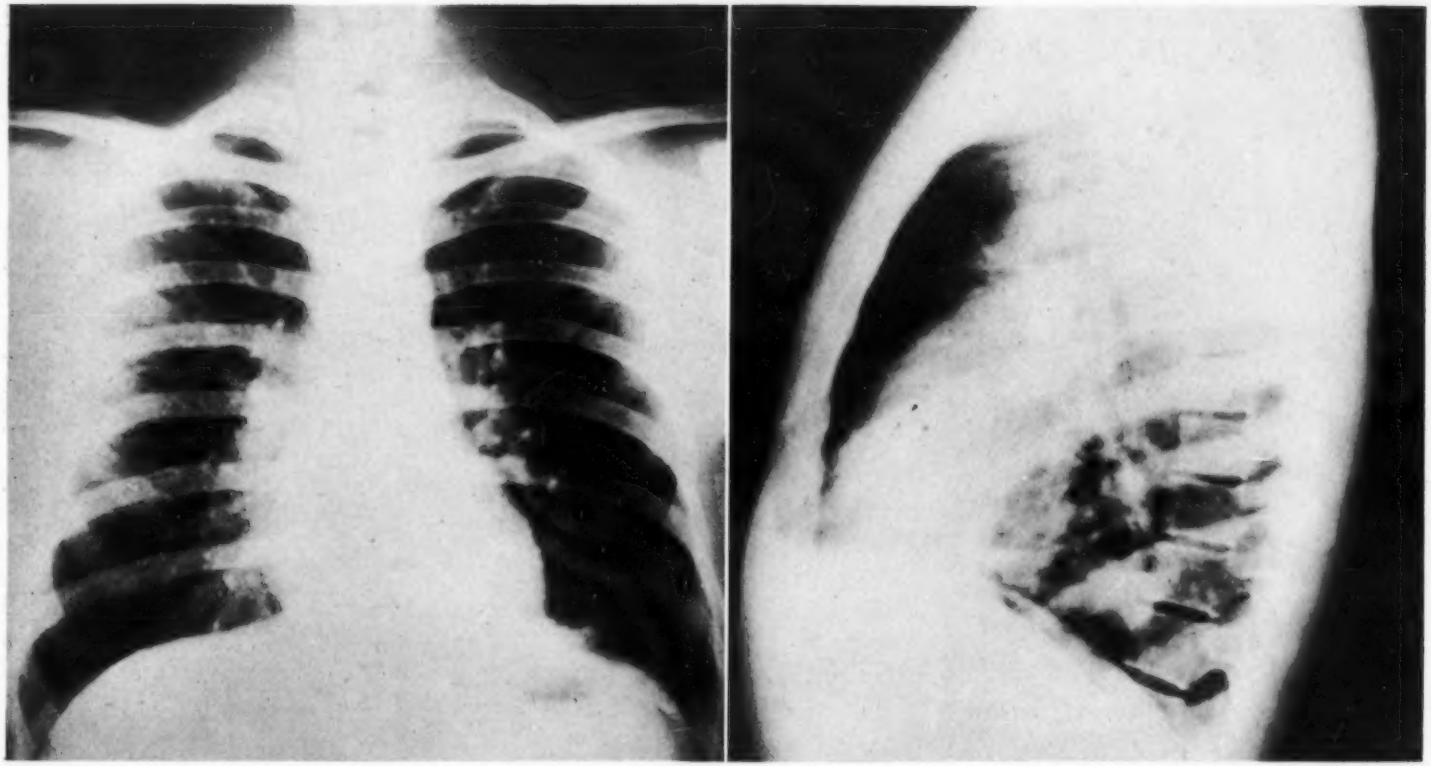

Figure 1A *Figure 1B*

Fig. 1A: Normal heart and lungs. Several calcified nodules in hilum. (Ant. View).—*Fig. 1B:* Horizontal fluid levels in several dense irregular shadows located behind heart and diaphragm due to bronchiectasis. (Lat. View).

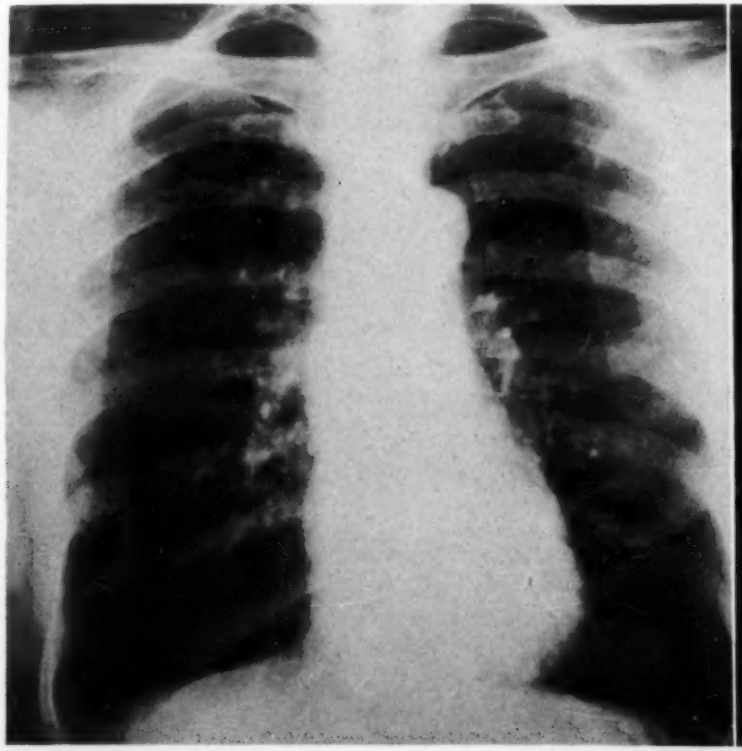

Figure 2B

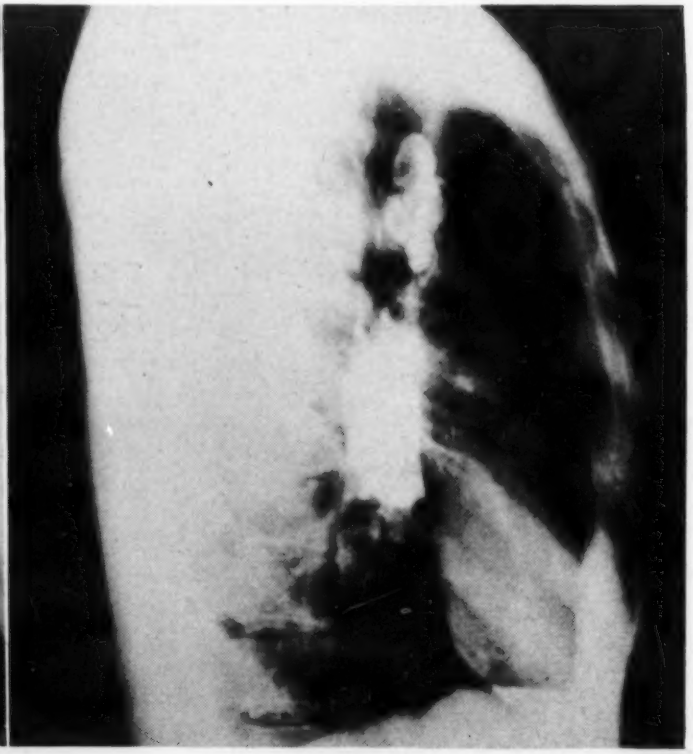

Figure 2A

Fig. 2A: **Normal heart and great vessels with emphysematous lungs. (Ant. View).—*Fig. 2B:* Calcified glands along the course of the trachea and upper bronchi, not seen in the anterior view. (Lat. View).**

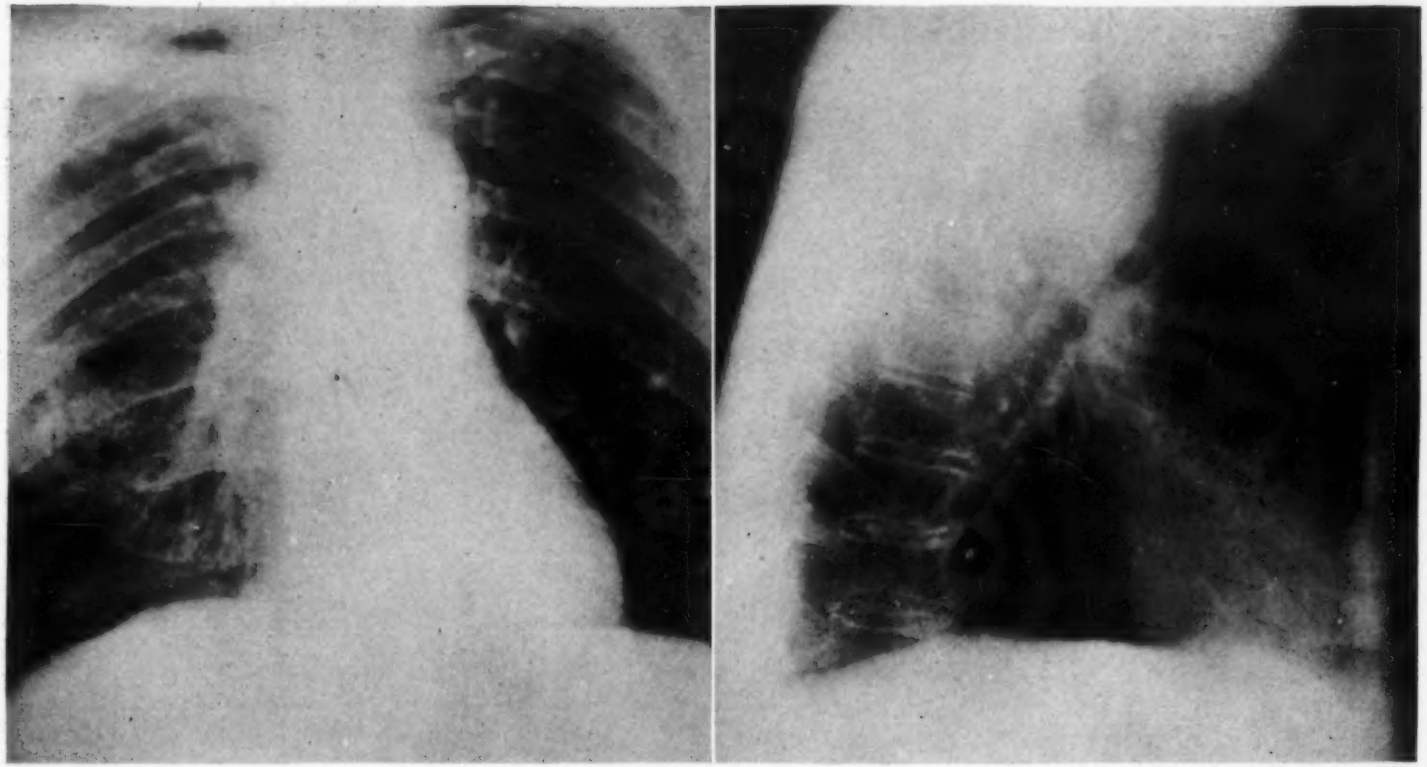

Figure 3A *Figure 3B*

Fig. 3A: Normal heart and great vessels. Lungs are clear. (Ant. View).—*Fig. 3B:* Metastatic tumor displacing the trachea forward which disappeared under x-ray treatment. (Lat. View).

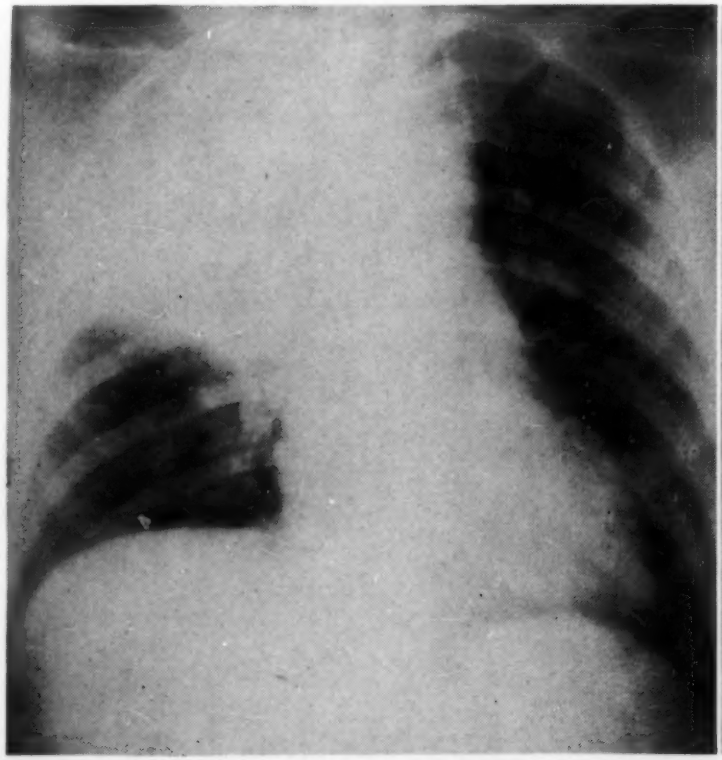

Figure 4A

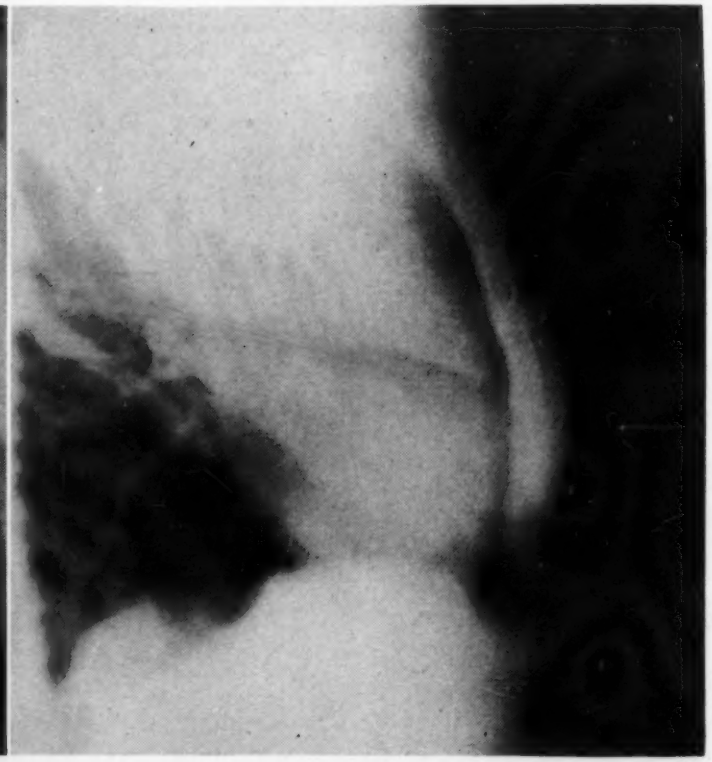

Figure 4B

Fig. 4A: Consolidation of the right upper lobe due to pneumonia. (Ant. View).—***Fig. 4B:*** Note the typical configuration of the right upper lobe with straight boundaries representing the oblique and horizontal interlobar fissures. (Lat. View).

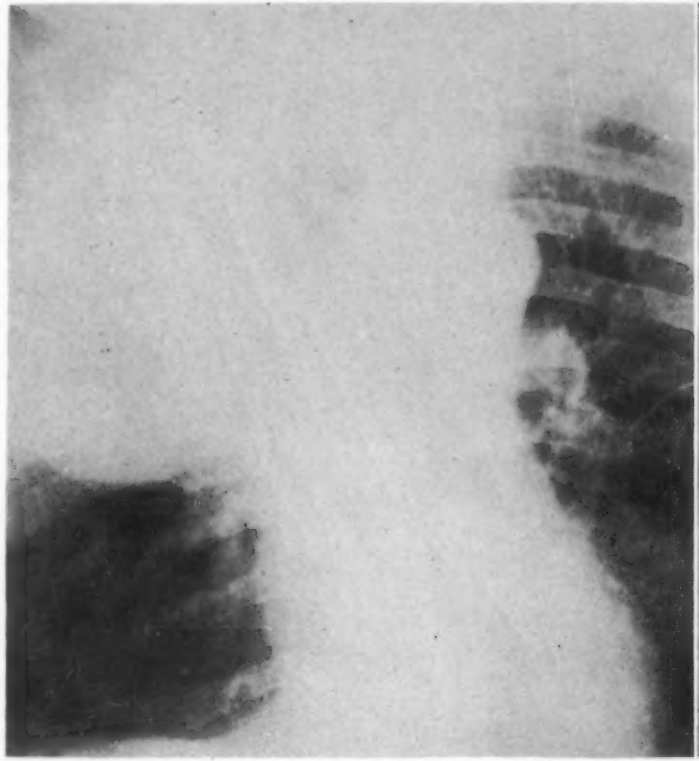

Figure 5A

Figure 5B

Fig. 5A: Consolidation of the right upper lobe due to a pulmonary tumor. Its lower boundary is convex. (Ant. View).—*Fig. 5B:* The margins representing the interlobar fissures are convex giving the mass a globular shape. (Lat. View).

the lateral view (Fig. 2B). Several large calcified glands are seen in the course of the trachea and hilar regions.

Case 3: In the anterior view (Fig. 3A) nothing remarkable is noted about the cardiovascular or pulmonary structures, but in the lateral view (Fig. 3B) the trachea is displaced forward by a soft mass. In view of the history of an operation for teratoma testis the lesion was considered to be of metastatic nature and was treated accordingly with x-ray. This resulted in complete disappearance of the nodule with restoration of the trachea to its normal position.

As a rule, the x-ray diagnosis of lobar pneumonia is not difficult to make even on a single anterior view; however, at times a pulmonary tumor or pleurisy with effusion may simulate in its appearance the shadow of a consolidated lobe. The differentiation depends upon the configuration of the shadow. In case the shadow is due to a consolidated lobe its shape will conform both in the anteroposterior and lateral views to the anatomical lobe. In case of a tumor the shadow assumes a globular or irregular appearance and in pleurisy with effusion it is variable.

Case 4: The anterior view (Fig. 4A) shows a uniform dense shadow in the region of the right upper lobe. The lower boundary is sharply defined and corresponds to the horizontal fissure between the upper and middle lobe. In the lateral view (Fig. 4B) the shadow is bounded posteriorly by the oblique interlobar fissure between the upper lobe and apex of the lower lobe. Below and anteriorly it is bounded by the horizontal fissure. The configuration of the shadow both in the anterior and lateral views corresponds exactly to the shape of the upper lobe. Hence the lesion is due to a pneumonic consolidation.

Case 5: The anterior view (Fig. 5A) shows a dense uniform shadow in the region of the right upper lobe. The lower boundary of the shadow is somewhat convex. In the lateral view (Fig. 5B) the lower and posterior boundaries are also more or less convex instead of being straight as in the previous case. Because of the general globular outline of the shadow the diagnosis of a pulmonary tumor was made and was proven to be correct.

Case 6: The anterior view (Fig. 6A) presents a dense shadow in the region of the middle lobe. The upper margin is sharply defined and corresponds to the horizontal fissure between the upper and middle lobes. In the lateral view (Fig. 6B) the dense shadow is triangular in shape, of uniform density and overlaps the heart shadow. The upper horizontal margin corresponds to the interlobar fissure between the upper and middle lobes. The lower margin is oblique and corresponds to the interlobar fissure between the middle and lower lobes. The anterior vertical margin is parallel to the anterior chest wall. The configuration of the shadow both in the anterior and lateral views corresponds to the shape of the middle lobe and is, as a rule, only found in pneumonic consolidation. If stereoscopy would do what some think it can do one should see the triangular shadow of the consolidated lobe in the anteroposterior position but in actual experience this is found to be impossible.

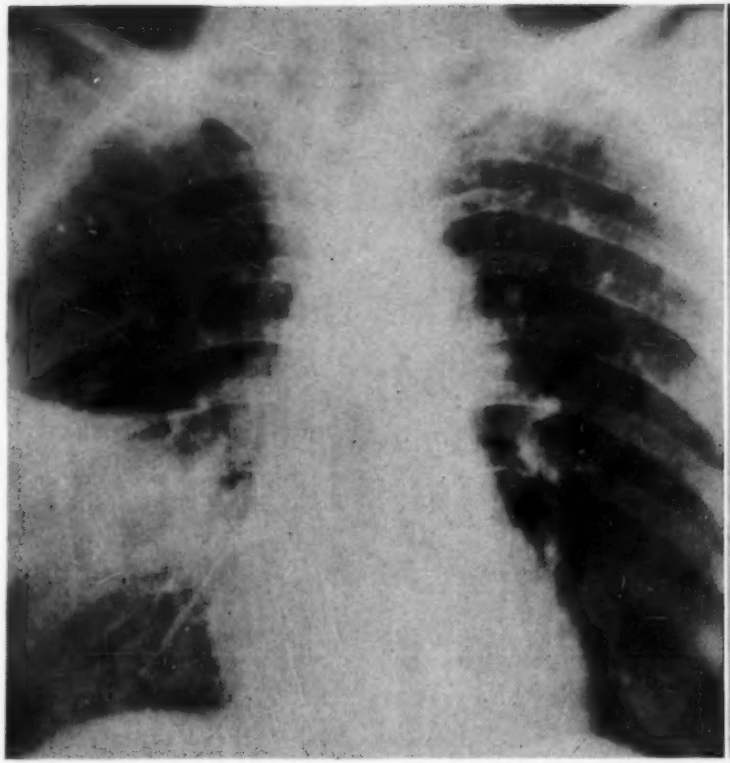

Figure 6A

Figure 6B

Fig. 6A: Pneumonic consolidation of the middle lobe. Upper boundary is sharp and corresponds to the horizontal fissure. (Ant. View).—*Fig. 6B:* Triangular dense shadow corresponding in shape to middle lobe. The boundaries are the horizontal and oblique interlobar fissures. (Lat. View).

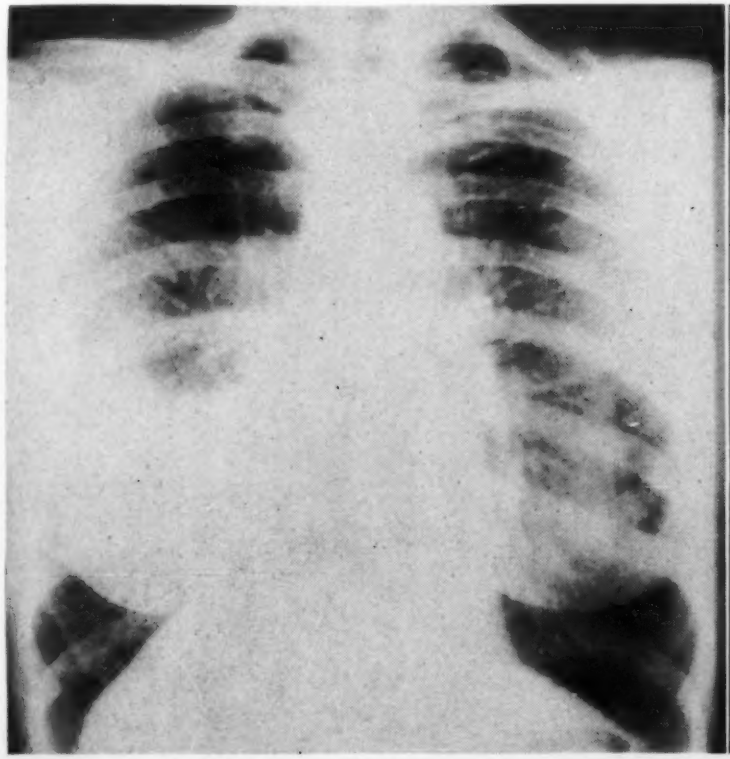

Figure 7A

Figure 7B

Fig. 7A: Dense shadow in region of middle lobe. Upper boundary is poorly defined. (Ant. View).—*Fig. 7B:* The dense shadow is oval-shaped and is in the course of the interlobar fissure between middle and lower lobes due to an interlobar pleurisy. (Lat. View).

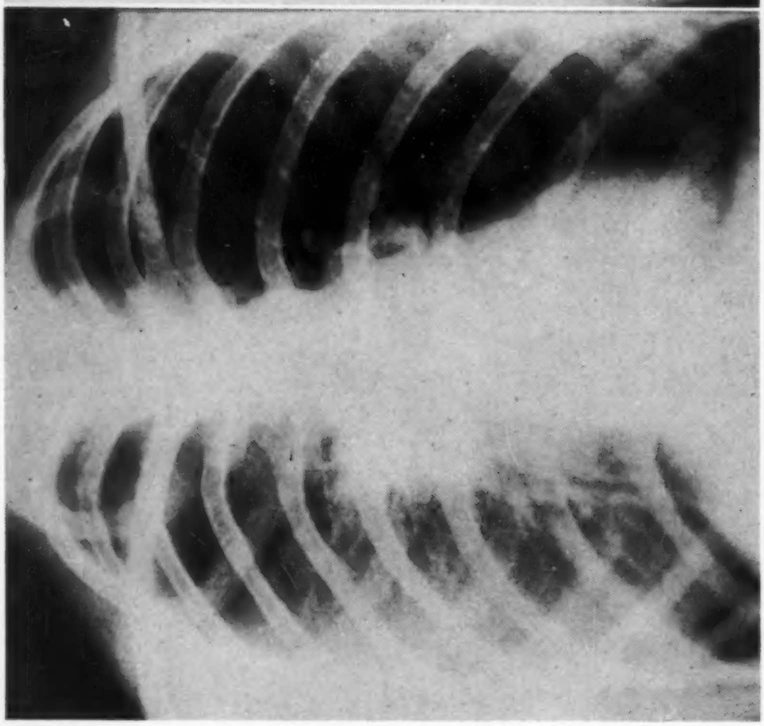

Figure 8A

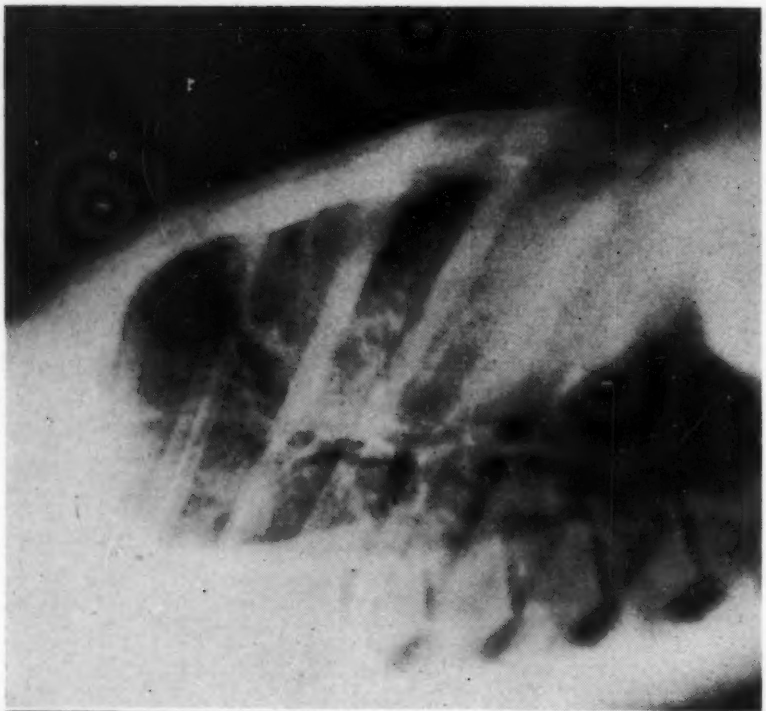

Figure 8B

Fig. 8A: A dense irregular shadow in the region of the right hilum. (Ant. View).—*Fig. 8B:* The dense shadow is located anteriorly along the course of the horizontal fissure due to a pleuro-pulmonary lesion.

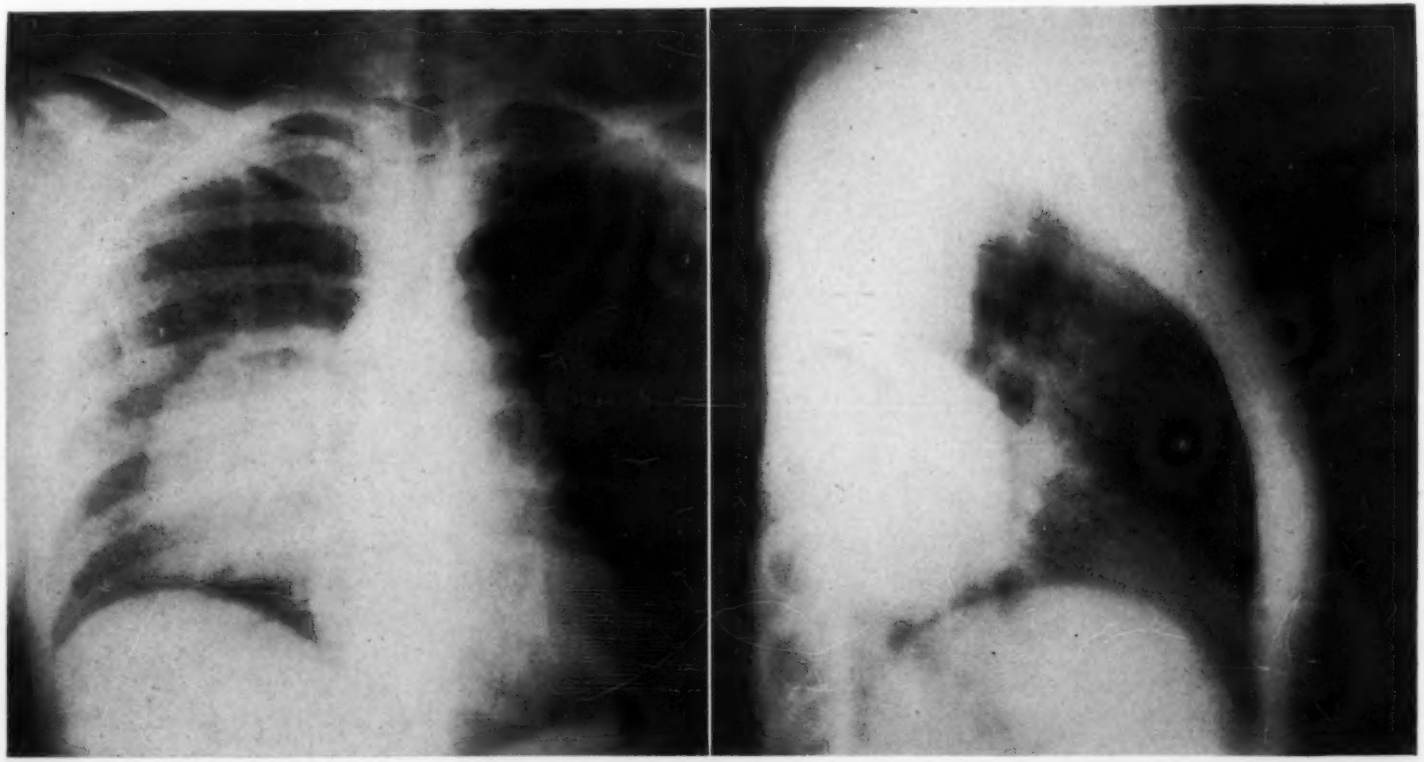

Figure 9A *Figure 9B*

Fig. 9A: Circumscribed oval shaped shadow on the right of the heart and great vessels (Ant. View).—*Fig. 9B:* The shadow is located posteriorly on the right side of spine due to an encapsulated empyema. (Lat. View).

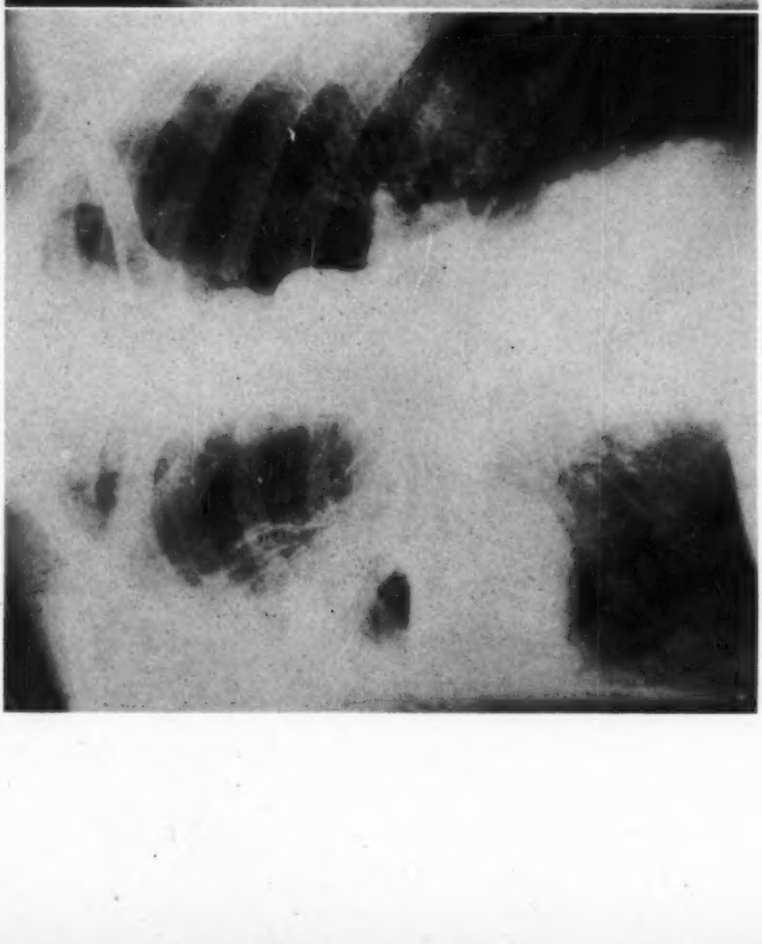

Figure 10A

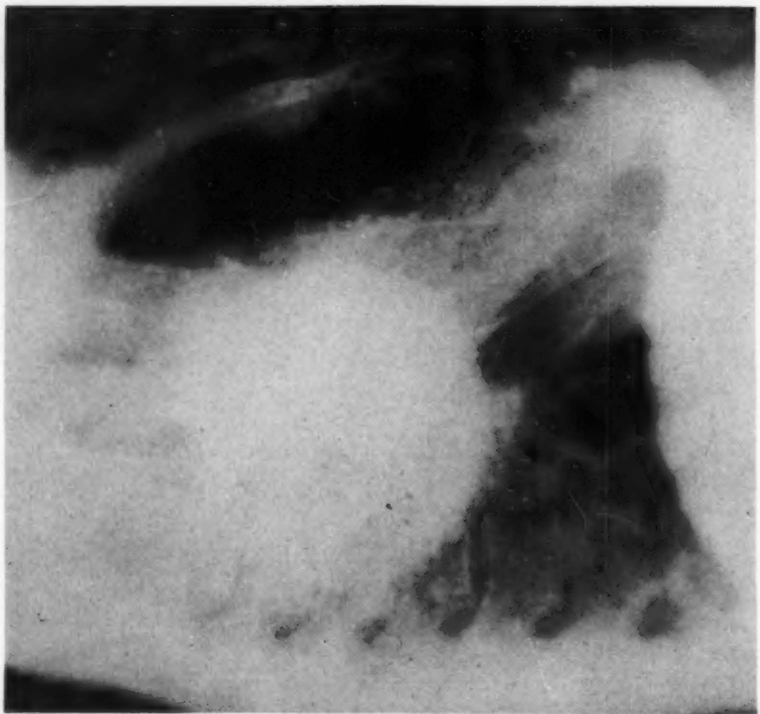

Figure 10B

Fig. 10A: Circumscribed dense shadow with fluid level in right lung thought to be due to an abscess. (Ant. View).—*Fig. 10B*: The dense shadow is located in the course of the oblique interlobar fissure and is due to an encapsulated empyema. (Lat. View).

Case 7: The anterior view (Fig. 7A) shows a dense shadow in the region of the middle lobe. In the lateral view (Fig. 7B) the dense shadow is oval shaped and is located along the oblique interlobar fissure between the lower and middle lobes. Its configuration is not that of the middle lobe but is due to a collection of fluid between the lobes due to an interlobar pleurisy.

Case 8: The anterior view (Fig. 8A) is of special interest because it was misinterpreted by many stereoscopic enthusiasts who thought that the dense shadow on the right side originated from the hilum. They were very much dismayed to see the lateral view (Fig. 7B) which showed the shadow located anteriorly adjacent to the horizontal interlobar fissure. Apparently it was due to a pneumo-pleuritic lesion.

The accurate location of an encapsulated empyema is absolutely essential for obvious reasons. The most satisfactory method is by means of the anteroposterior and lateral positions.

Case 9: The anterior view (Fig. 9A) shows an oval shaped shadow of uniform consistence in the right lung field along the right cardiovascular border. The patient recovered from a pneumonia but soon afterwards developed symptoms suggestive of an abscess or empyema. Stereoscopic views in the anterior position were taken elsewhere but in spite of these they were unable to determine the exact location or the true nature of the shadow. On fluoroscopic examination the patient was turned on the side and in a moment it was quite evident to everyone present that the shadow was located posteriorly and was related to the interlobar fissure as shown in the lateral view (Fig. 9B). The diagnosis of an encapsulated empyema was confirmed by operation.

Case 10: The anterior view (Fig. 10A) shows a circumscribed dense shadow with a horizontal fluid level in the right lung. It was considered to be a pulmonary abscess because of the fluid level. In the lateral view (Fig. 10B) the shadow lies along the course of the oblique interlobar fissure and is sharply defined. The interlobar fissure below the shadow is thickened and apparently adherent preventing the fluid from extending toward the base. The air within the shadow was undoubtedly due to attempts at aspiration of the fluid. The immediate recovery after operation fully confirmed the fact that the lesion was due to an encapsulated empyema rather than a pulmonary abscess.

The importance of correct localization of pulmonary abscesses is just as valid as in the case of encapsulated empyema and its accomplishment is attained in the same manner.

Case 11: The anterior view (Fig. 11A) shows a dense shadow with a fluid level in the region of the middle lobe. In the lateral view (Fig. 11B) the shadow of the abscess is located just behind the anterior chest wall and to the right of the sternum. It would seem that the localization of the abscess ought to have satisfied any surgeon, but to my surprise a request was made for stereoscopic views in the anterior position. These were made but in spite of them the surgeon could not find the abscess. The reason, as I found out later, was due to the fact that the incision was made at the periphery of the chest instead of medially near the sternum where the abscess was shown to be located. I am still puzzled

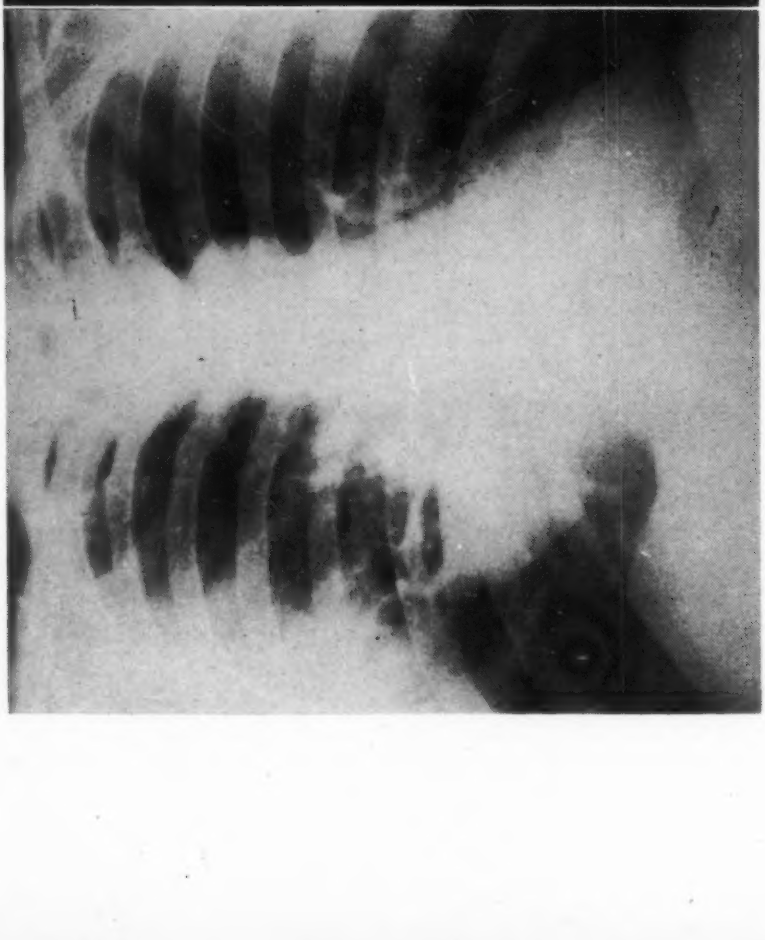

Figure 11A

Figure 11B

Fig. 11A: Dense shadow with fluid level in region of middle lobe due to an abscess. (Ant. View).—*Fig. 11B*: The abscess is located anteriorly behind anterior chest wall to right of sternum. (Lat. View).

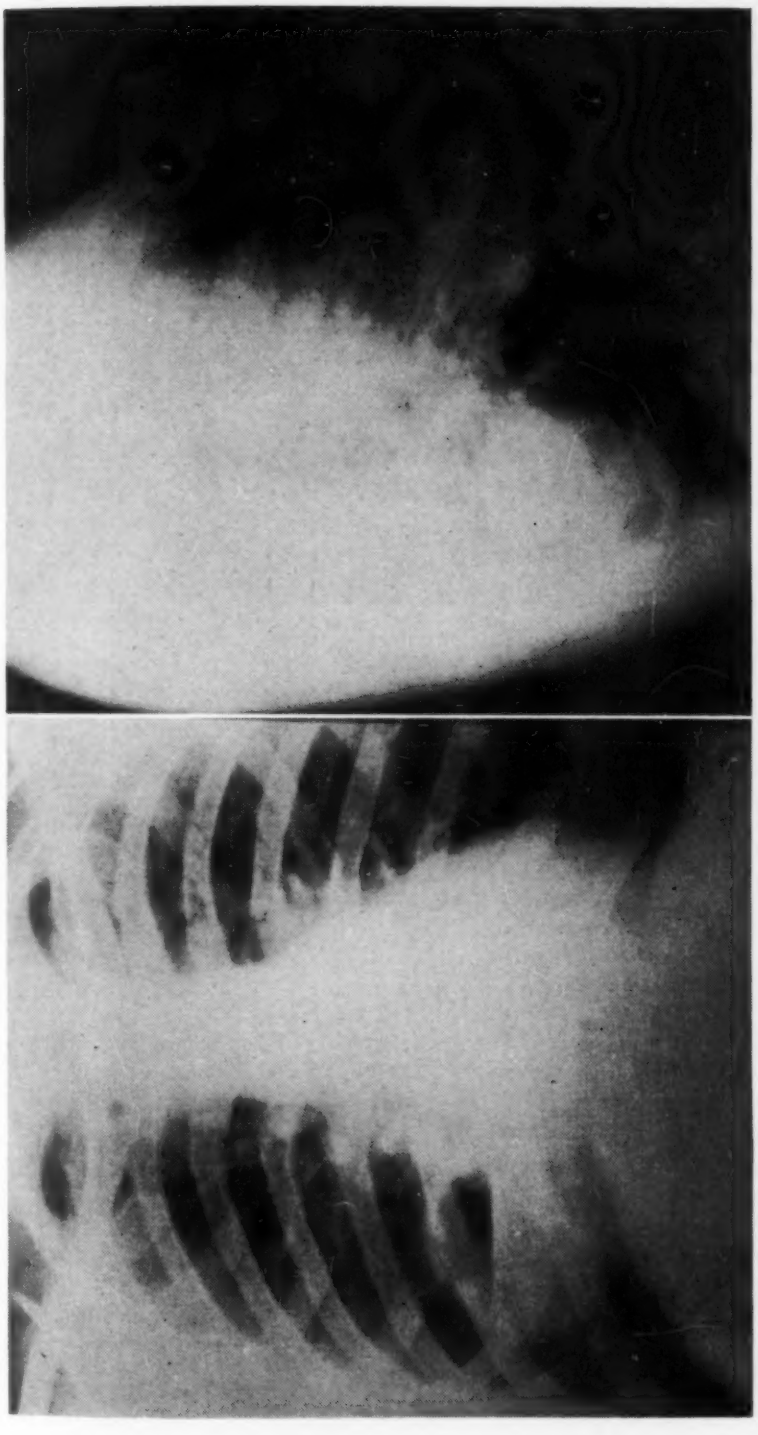

Figure 12B

Figure 12A

Fig. 12A: Dense shadow with fluid level in the region of middle lobe due to an abscess. (Ant. View).—*Fig. 12B:* The abscess is located not in the middle lobe, but posteriorly in the lower lobe to right of the spine. (Lat. View).

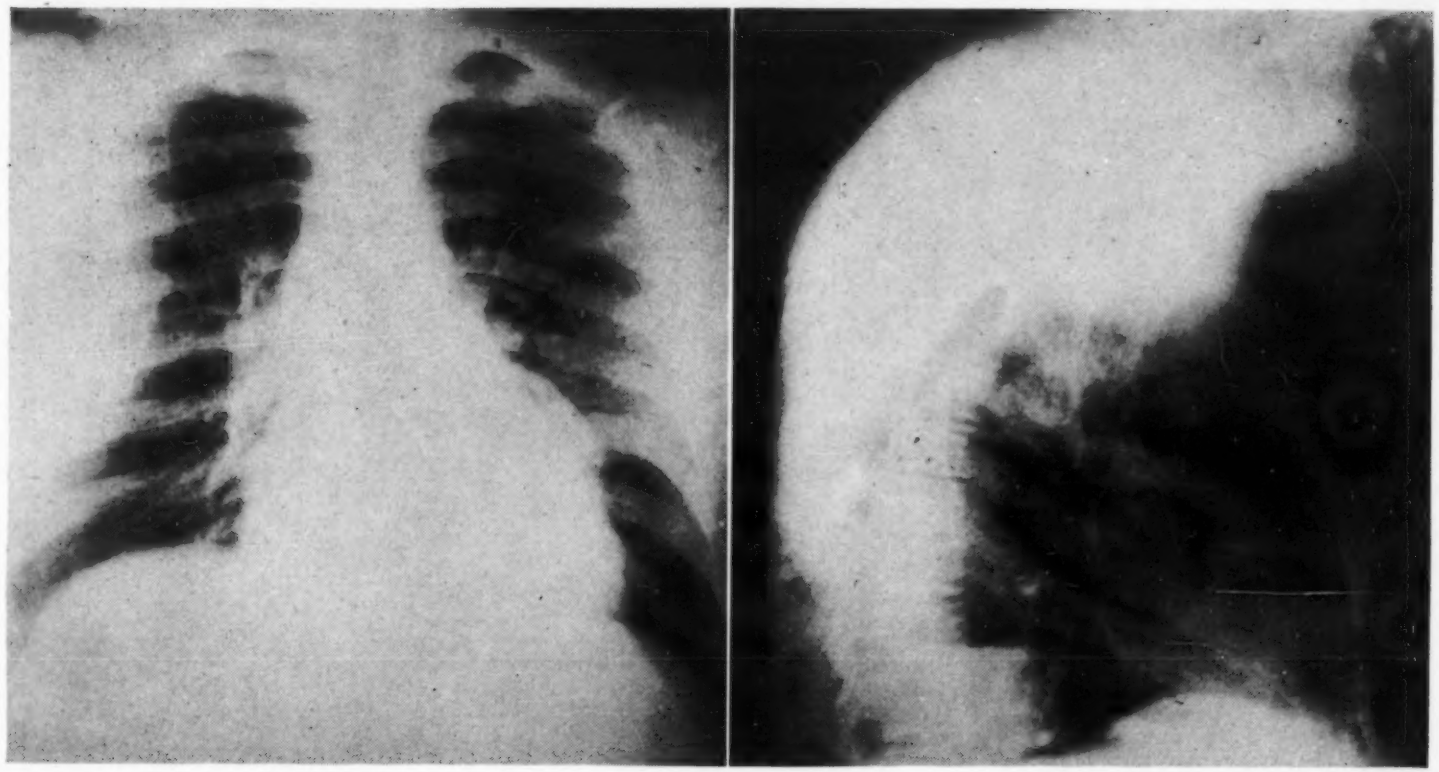

Figure 13A *Figure 13B*

Fig. 13A: Dense shadow along the left cardiac border, the nature of which is uncertain. (Ant. View).—***Fig. 13B:*** Dense shadow with fluid level located to the left of spine and obscured completely by the heart. (Lat. View).

as to why the surgeon got such a wrong impression from the stereoscopic views when the true location was so evident. When attention was again called to the exact location, the operation proceeded without interruption and terminated successfully.

Case 12: The anterior view (Fig. 12A) shows a circumscribed dense shadow with a fluid level due to a pulmonary abscess. It is located, as in the previous case, in the region of the middle lobe, but in the lateral view (Fig. 12B) the shadow is seen to be located posteriorly on the right side of the spine in the lower lobe.

Case 13: The anterior view (Fig. 13A) shows nothing unusual except a dense narrow shadow along the left border of the heart, the nature of this is uncertain. In the lateral view (Fig. 13B) a dense shadow with a fluid level is seen overlapping the spine and is due to an abscess in the left lower lobe. It was completely obscured by the heart shadow.

The diagnosis of pulmonary tumors is, generally speaking, not difficult; however, as mentioned before, when they are entirely obscured by the cardiovascular shadow, a lateral projection is necessary. Even when located in the lung field their exact localization is essential for a more accurate diagnosis so again the lateral view is necessary.

Case 14: In the anterior view (Fig. 14A) a dense circumscribed shadow is seen in the region of the right upper lobe which appears to involve most of the lobe, but in the lateral position (Fig. 14B) the shadow is located posteriorly and involved only the posterior one-third of the parenchyma.

Case 15: The anterior view (Fig. 15A) shows a small nodule above the left diaphragm and to the left of the cardiac border. In the lateral view (Fig. 15B) the shadow is located in the mid-axillary line in the left lower lobe and is adherent to the diaphragm. Above there are noted dense striae extending to the hilum. With a knowledge of the exact location of the tumor it was possible to do an aspiration biopsy which proved the malignancy of the nodule. On operation the hilar region was found to be involved and it was considered to be inoperable.

Case 16: The anterior view (Fig. 16A) shows an area of greater density in the region of the right cardiophrenic angle. The outline of the diaphragm is more or less obscured by the shadow. In the lateral view (Fig. 16B) the dense shadow appears to be limited to the anterior portion of the lower lobe. Above, the shadow extends to the hilum. The diagnosis of a new growth was confirmed by operation at which time it was found to be inoperable.

I find no special advantage in taking a lateral view of an early or moderately advanced pulmonary tuberculosis. The superposition of the lungs more or less obscures the parenchymatous changes, but in advanced cases it was found that the lateral view often gives more accurate information of the state of the pathological process. It also often helps to determine the exact lobe or lobes which are involved.

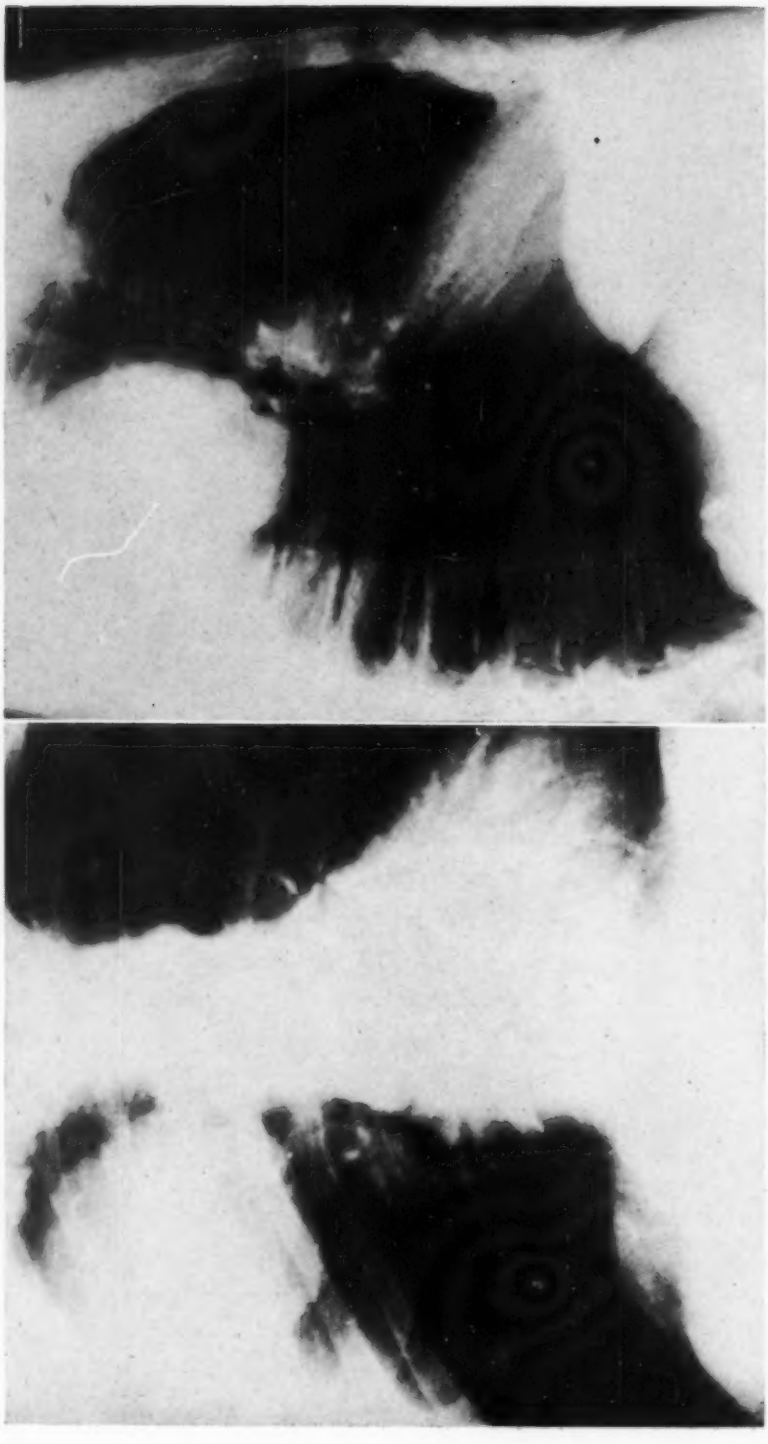

Figure 14B

Figure 14A

Fig. 14A: Dense circumscribed shadow in the right upper lobe due to a tumor. (Ant. View).—*Fig. 14B:* The tumor involves the posterior portion of the upper lobe. (Lat. View).

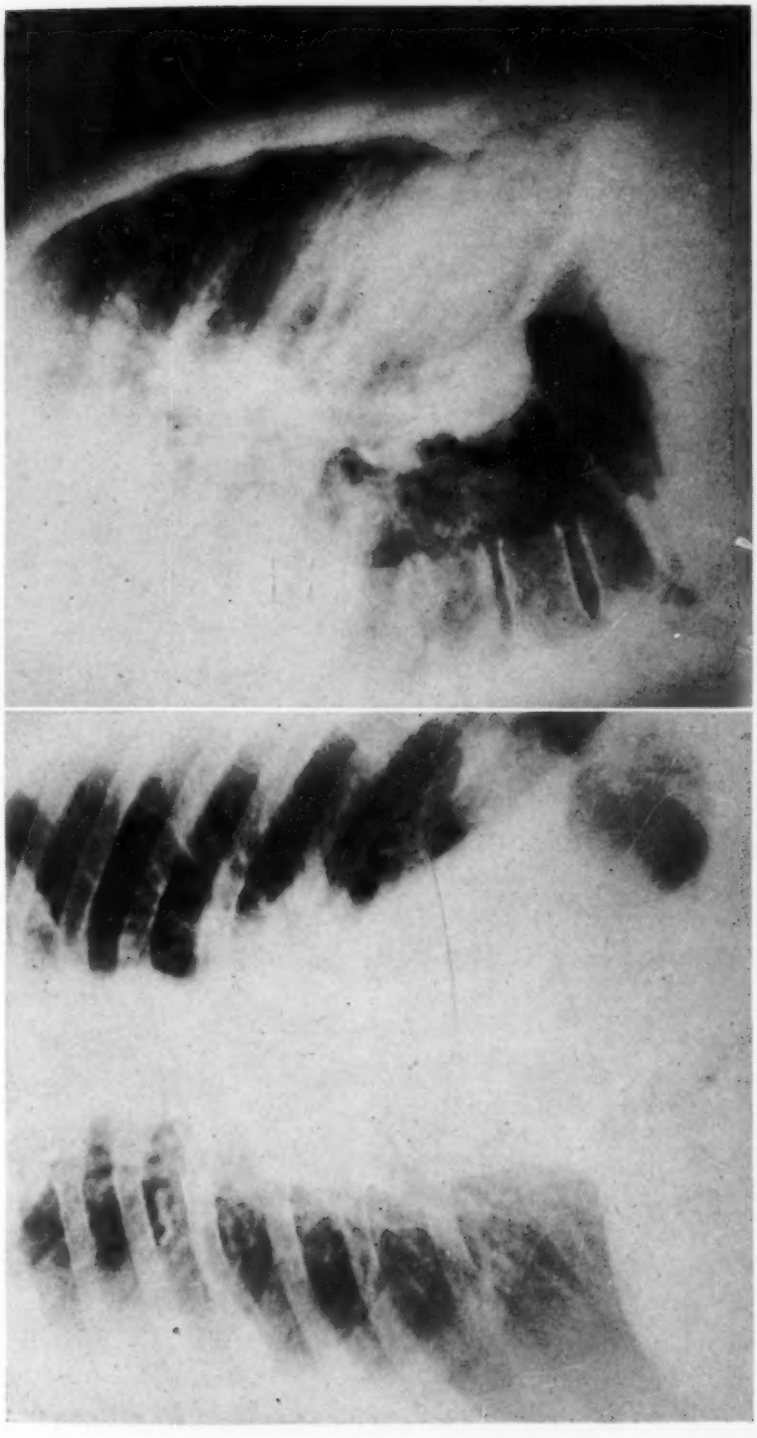

Figure 15A *Figure 15B*

Fig. 15A: Dense shadow at the base of left lung due to a tumor. (Ant. View).—*Fig. 15B:* The tumor is located in the middle of thorax and is adherent to diaphragm extending also to hilum. (Lat. View).

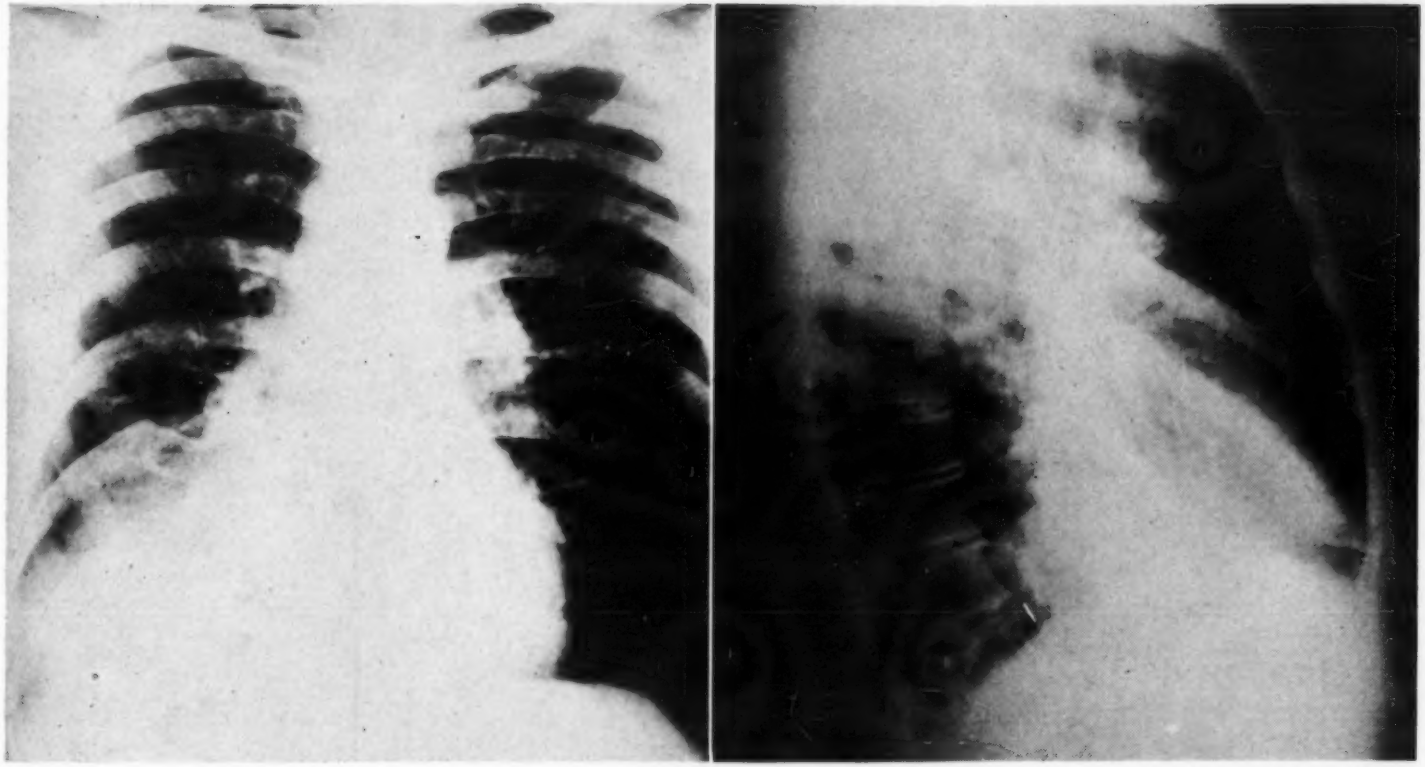

Figure 16A *Figure 16B*

Fig. 16A: Dense shadow in the region of the cardio-phrenic angle on the right side due to a tumor. (Ant. View).—***Fig. 16B:*** The tumor involves the anterior portion of lower lobe being sharply separated from the upper lobe by the oblique fissure. (Lat. View).

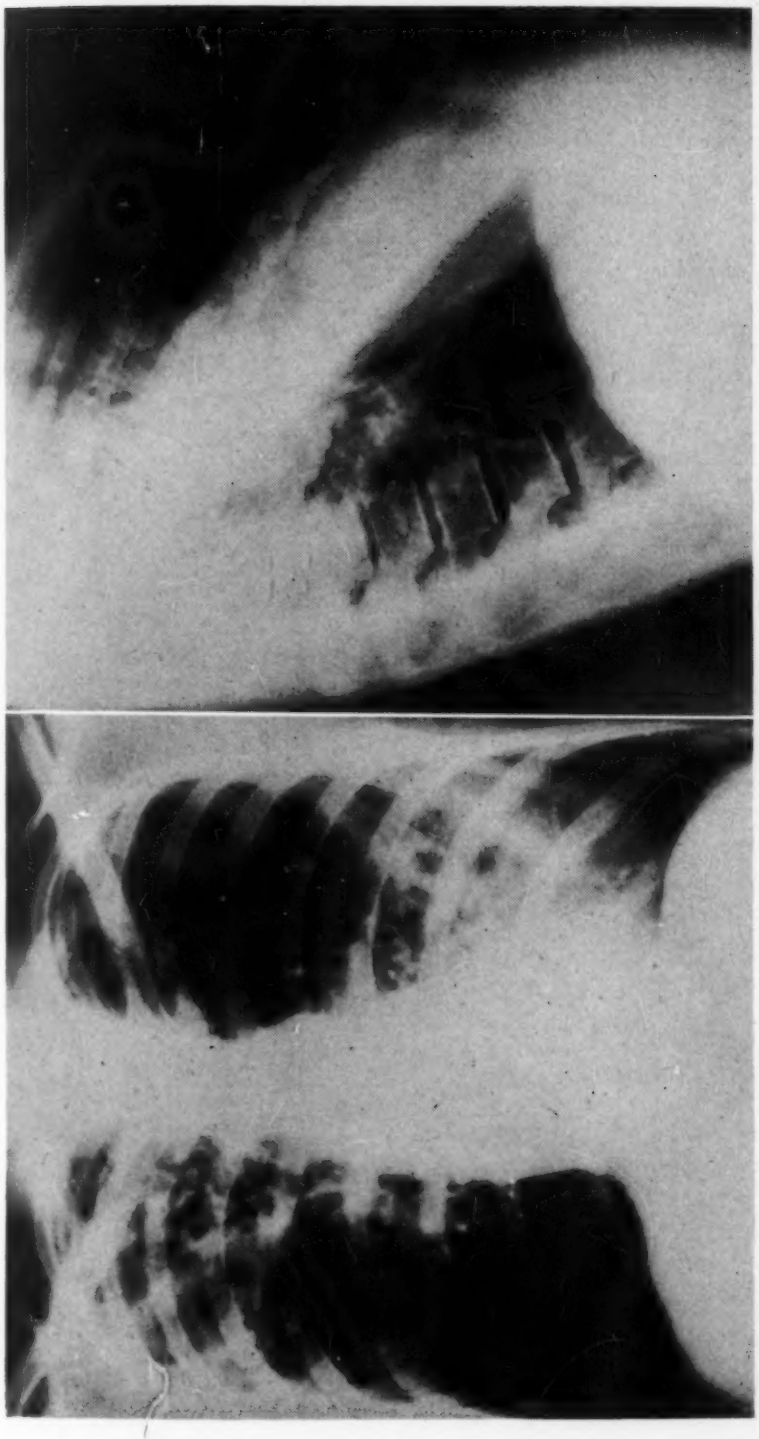

Figure 17A

Figure 17B

Fig. 17A: Pulmonary tuberculosis of the right upper lobe and apparently the left lower lobe. (Ant. View).—*Fig. 17B:* The lower lobes of each lung are clear. The lower segment of the left upper lobe is involved. (Lat. View).

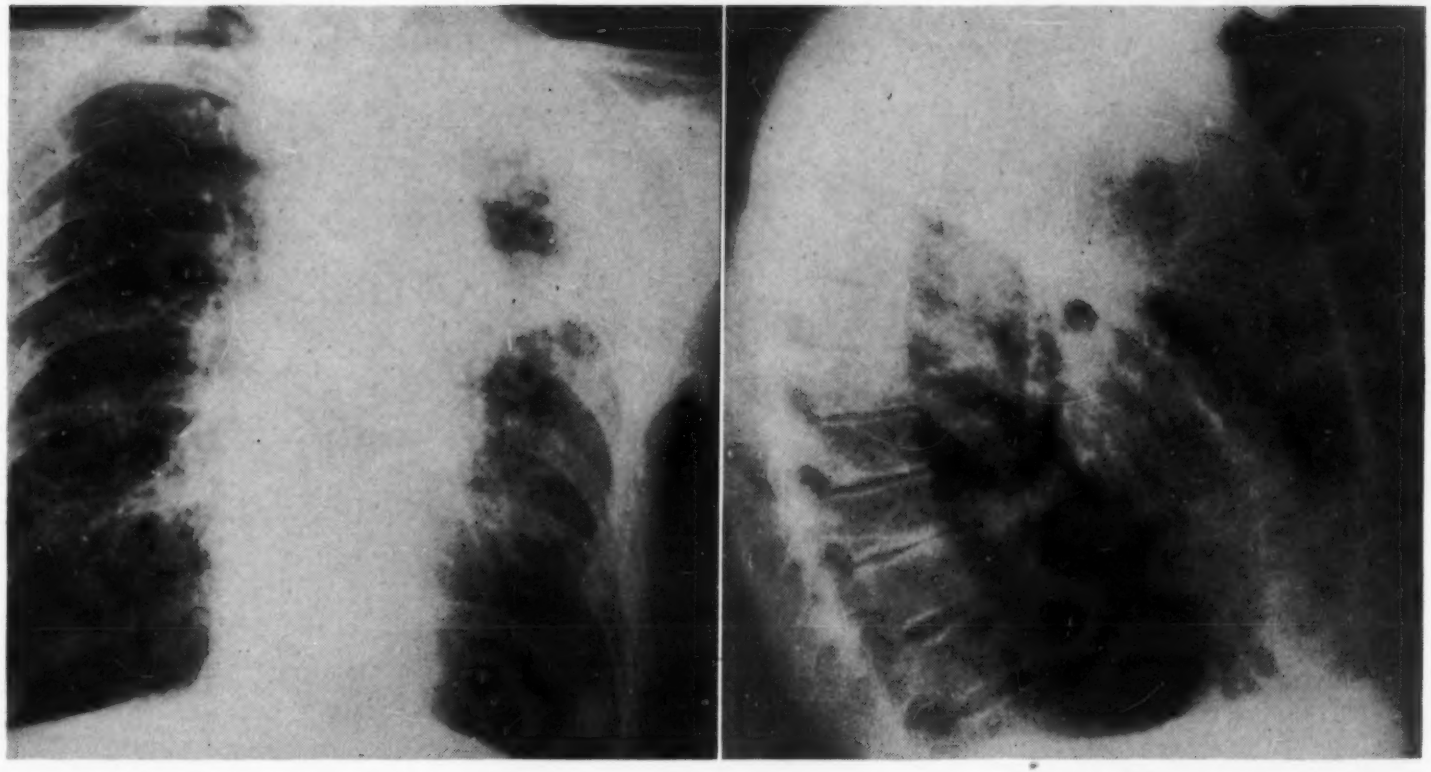

Figure 18A *Figure 18B*

Fig. 18A: The left upper lobe shows a tuberculous process. The great vessels are displaced to the left. (Ant. View).—***Fig. 18B:*** The oblique interlobar fissure is displaced forward on account of atelectasis of the upper lobe. The lower lobe is emphysematous. (Lat. View).

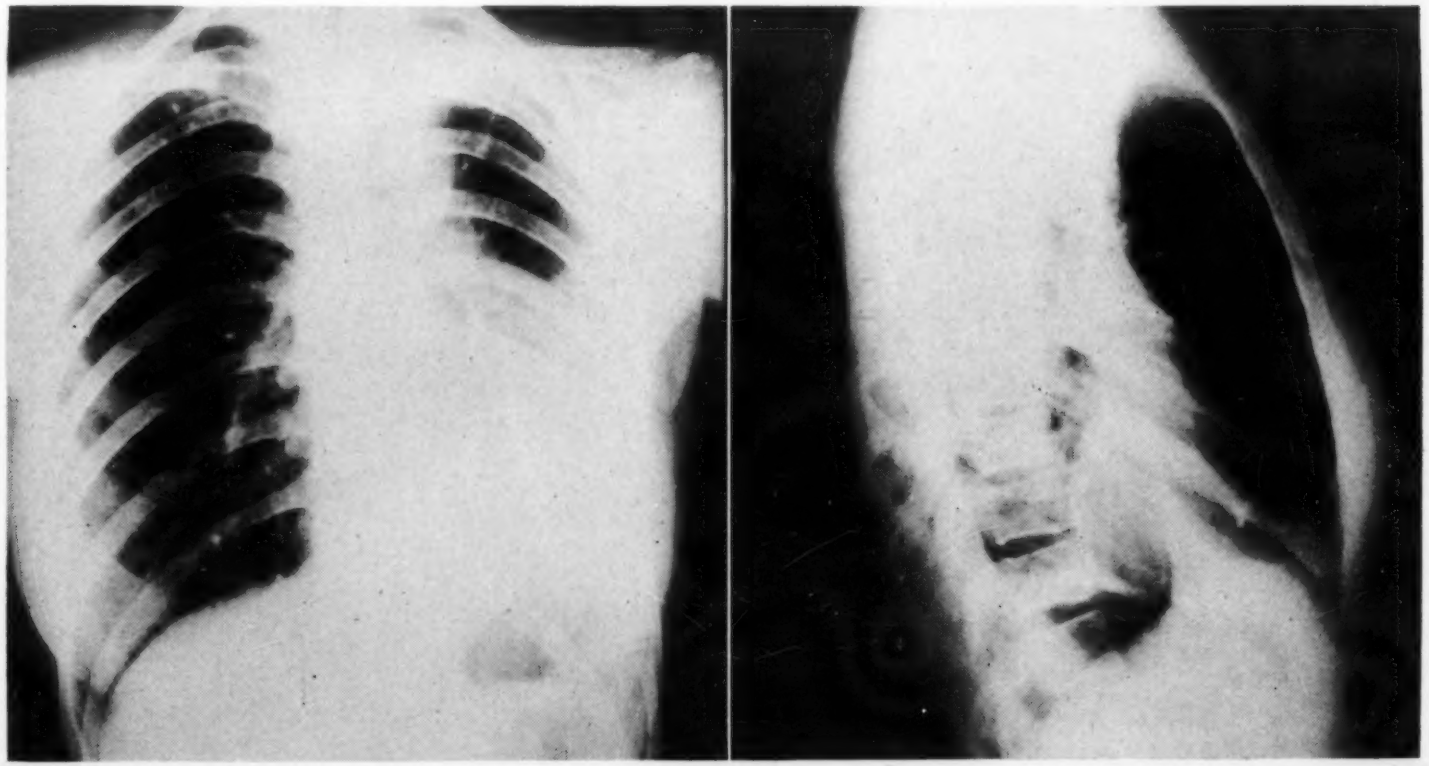

Figure 19A *Figure 19B*

Fig. 19A: The middle mediastinal structures are displaced to left due to atelectasis of the left lower lobe. (Ant. View).—***Fig. 19B:*** The heart and vessels are also displaced backward due to atelectasis of the lower lobe, while the upper lobe is markedly emphysematous and occupies the entire retro-sternal space. (Lat. View).

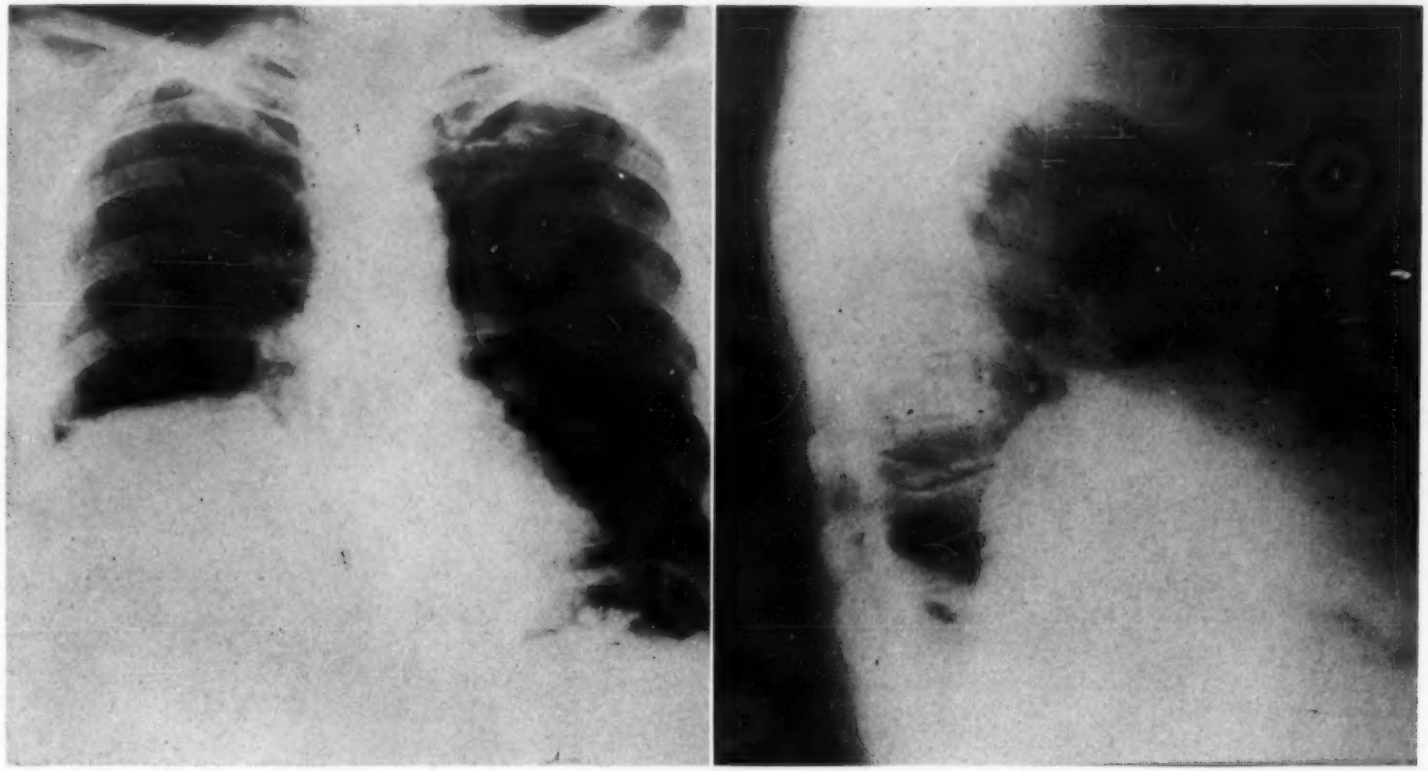

Figure 20A *Figure 20B*

Fig. 20A: Right diaphragm is elevated and its excursions are limited. (Ant. View).—***Fig. 20B:*** The posterior costo-phrenic angle is clear and is lower than the anterior. This is due to an enlarged liver. (Lat. View).

Case 17: The anterior view (Fig. 17A) shows parenchymatous infiltration of a tuberculous nature in the right upper and left lower lobe. However, in the lateral position (Fig. 17B) the lower lobes of both lungs are clear. The upper lobe of the left lung shows involvement along its posterior boundary. The boundary of the oblique interlobar fissure is sharply outlined which nicely illustrates its exact position as it bisects the lung diagonally into two equal parts.

Case 18: The anterior view (Fig. 18A) shows marked involvement of the left upper lobe apparently as a result of a chronic pulmonary tuberculosis. The great vessels are shifted somewhat to the left and their borders are obscured by the dense pulmonary shadow. In the lateral view (Fig. 18B) the interlobar fissure is shifted forward as a result of partial atelectasis of the upper lobe, while the parenchyma of the lower lobe is emphysematous and its size is increased to compensate for the collapse of the upper lobe.

Case 19: The anterior view (Fig. 19A) shows complete displacement of the cardiovascular shadow to the left apparently as a result of atelectasis of the lower left lobe. In the lateral view (Fig. 19B) the heart and great vessels are also displaced backward and the apex of the heart is pointing toward the spine. The anterior clear space is greatly enlarged due to emphysema of the upper lobe. Could anyone imagine the existence of the above changes without the lateral view?

Attention has already been called to the normal position of the diaphragm both in the anterior and lateral projections. Under abnormal conditions the diaphragm may be found to be elevated or displaced downward. The most frequent and important finding is elevation of the right diaphragm which may be due either to an enlarged liver or a subphrenic abscess. It is evident that the differentiation between the two conditions is of utmost importance. The two following cases will help in making such a diagnosis.

Case 20: The anterior view (Fig. 20A) shows elevation of the right diaphragm. Its mobility was found to be limited. In the lateral view (Fig. 20B) the diaphragmatic arc is greatly increased, but the posterior costophrenic angle is not obliterated and the relative heights of the anterior and posterior attachments remain constant. As a rule, such changes are found frequently as a result of an enlarged liver, increased intra-abdominal pressure or phrenic paralysis. In this case it was due to an enlarged liver.

Case 21: The anterior view (Fig. 21A) shows elevation of the right diaphragm with impaired mobility as in the previous case, but in the lateral view (Fig. 21B) the posterior costo-phrenic angle is completely obliterated and the post-diaphragmatic attachment appears to be on a higher level than the anterior. The whole diaphragmatic surface appears to be flattened giving one the idea of a plateau, hence it is called the plateau sign of subphrenic abscess which is the lesion very often found in the presence of such a diaphragmatic configuration. The importance of this sign has been demonstrated in a number of cases as confirmed by operation; although the clinical, physical and the usual x-ray findings were indefinite.

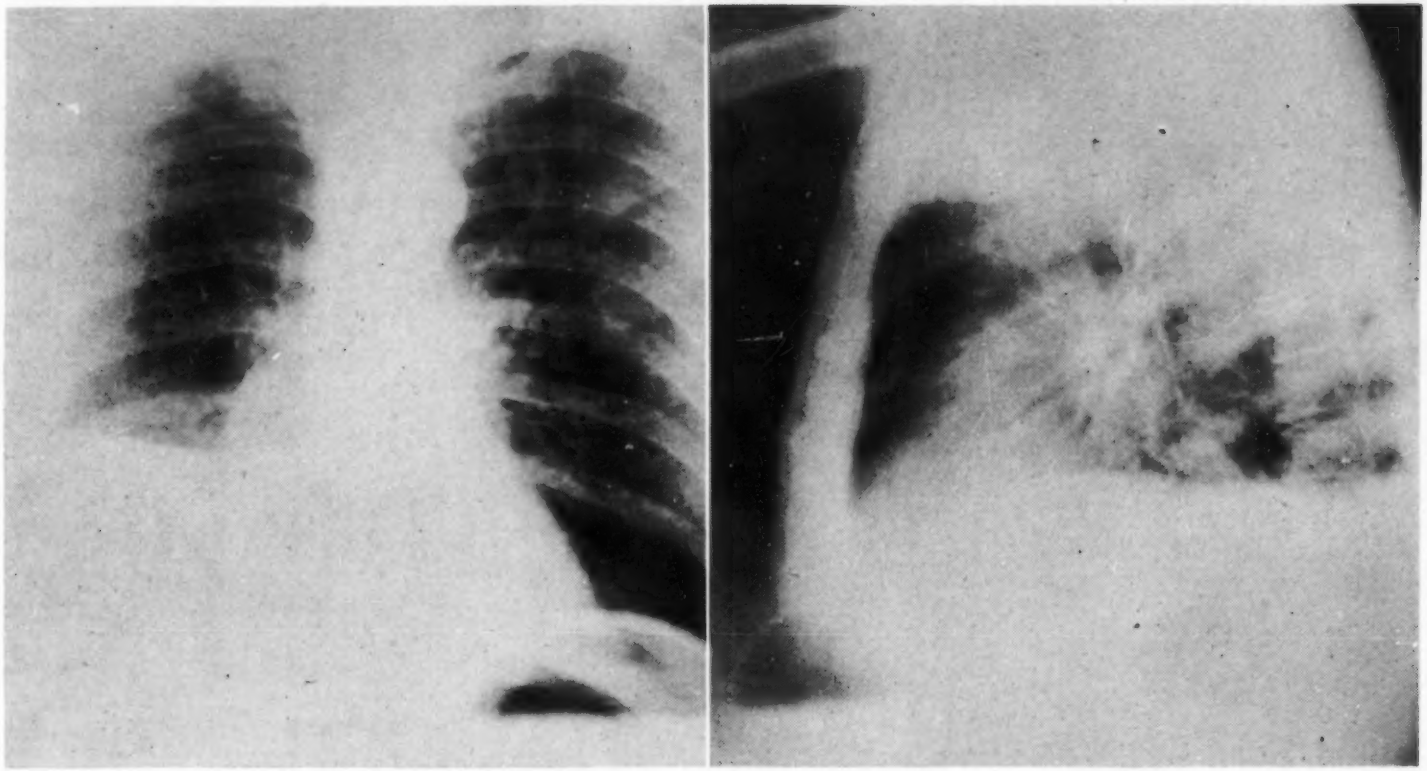

Figure 21A *Figure 21B*

Fig. 21A: Right diaphragm is elevated and its excursions are limited. (Ant. View).—*Fig. 21B:* The posterior costo-phrenic angle is obliterated. The diaphragm is flattened. This is frequently found in subphrenic abscess. (Lat. View).

CONCLUSION

The application or use of anterior and lateral projections in the study of the chest in many thousands of cases has convinced me that its value is of no less importance than in the examination of an extremity for a possible fracture or dislocation. By their use one obtains a more accurate knowledge of the position, shape, size and relationship of abnormal shadows than is ever possible by stereoscopy taken in one direction alone. The information thus obtained leads one to a more accurate diagnosis which is the goal of every examination.

CONCLUSION

La aplicación o el uso de las proyecciones anteriores y laterales en el estudio del tórax en muchos miles de casos me ha convencido de que su valor es de tanta importancia como en el examen de una extremidad por una posible fractura o dislocación. Mediante su uso se obtiene una idea más exacta de la posición, forma, tamaño y relación de las sombras anormales que lo que es posible obtener con la estereoscopía tomada en una sola dirección. La información así obtenida nos conduce al diagnóstico más exacto, que es el objeto de todo examen.

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Clinical Value of Angiocardiography*

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Filling of the heart chambers and great vessels with contrast substance reveals their anatomical structure, and permits differentiation of vascular from non-vascular mediastinal lesions. The method, contrast substance used, and procedure, have been described. Angiocardiography has revealed that our knowledge of the position of the heart chambers and the border-forming structures of the cardiac silhouette in the normal and abnormal was not in complete accord with text book descriptions. This type of examination allows a demonstration of (1) congenital anomalies, (2) anatomical variations, (3) chamber enlargement, cardiac hypertrophy, or both, (4) constricted and expanded cardio-vascular lesions, and (5) the differentiation of the vascular from the non-vascular mediastinal lesions.

The following cases illustrate cardio-vascular lesions:

Case 1: E. H., a white female, aged 93, was admitted to this hospital on 4/25/41, and died on 5/14/42. A history was unobtainable, because of patient's poor memory, but she claimed "she did not have a care in the world, and never felt better in her life." She was transferred from another hospital with a diagnosis of a Pott's fracture of the ankle, and for custodial care.

Physical examination revealed a slight, aged, white female, poorly nourished and developed. Her pupils reacted to light and accommodation. Ears, nose and throat showed no abnormality. Examination of the chest showed shallow lung excursion, distant breath sounds, and no rales. Her heart sounds were distant and of poor quality. A_2 was accentuated. Pulse rate was 72, blood pressure 92/100. Her abdomen was essentially negative. Her extremities showed slight pretibial edema, and her right ankle showed evidence of a recent Pott's fracture. There was no deformity of either ankle or foot. Vessels were not palpable in either foot.

Laboratory work revealed a blood sugar of 82.5 mgm.%; blood urea nitrogen 29.4 mgm.%; Wassermann was negative; Kline doubtful.

The patient received custodial care and physiotherapy, and her course was uneventful until April 20, 1942, when she had a moderate hemoptysis. Examination of the chest at this time was essentially negative, except for moist rales in both bases, posteriorly. Later the same day, she began to bring up copious quantities of bright red frothy blood. It was decided that the patient was probably bleeding from an open vessel from the pharynx or tracheo-bronchial tree. A nose and throat consultation showed no pathology or bleeding vessel.

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On April 21, 1942, a roentgenographic examination of the chest revealed a large circumscribed area of absent aeration in the central portion of the left lung, which extended from the axillary portion of the chest to the hilum, merging with the mediastinal structures. In the lateral projection, the circumscribed area of absent aeration was superimposed over the heart and the superior mediastinum. While an aneurysm could not be excluded, the area of diminished aeration was thought to be an encapsulated effusion.

Clinically, it was thought that the mass in the chest might be a dissecting aneurysm or mediastinal tumor, though most likely an effusion. On April 24, 1942, a chest tap was performed, and blood appeared in the syringe, under considerable pressure. A specimen showed no neoplastic cells, revealed a red blood count of 3.6, Hgb 56%, white blood count of 11,000 and a negative culture. On April 25, 1942, an aneurysmal dilatation of the abdominal aorta was palpated, just above the umbilicus, which was tender. A film of the chest on May 5, 1942, showed no change when compared with the previous examination. Because of the history, a diagnosis of an aneurysm was made. It was decided to make angiocardiographic studies. On May 11, 1942, these studies were performed without any after effects, and revealed the following:

Angiocardiographic examination (Fig. 1) was made in the supine position, with contrast substance injected into the left external jugular vein. At the end of 4 seconds, contrast substance was visualized in the entire right heart, pulmonary aorta, right and left pulmonary arteries. Contrast substance was also visualized in the left jugular vein, collateral circulation in the neck, left subclavian and superior vena cava. The cardiac silhouette was very small. The contrast substance in the right heart was relatively large.

At the end of 12 seconds, contrast substance was distributed throughout the entire thoracic portion of the aorta and the left heart. The ascending portion of the aorta was tortuous. The descending portion showed a large aneurysm at the left lateral aspect of the aorta; the aneurysm extended from the 6th to the 9th rib. The contrast substance in the aneurysm did not fill the entire opacity in the left hemithorax. The outline of the contrast substance warranted the description of saccular. The appearance, however, was not truly saccular. Lateral to the opacified portion of the aneurysm was a thick clot. Because of the age of the patient, and the clinical history, this was considered as an arteriosclerotic aneurysm.

Contrast substance was demonstrated in the abdominal aorta down to the bifurcation and in the iliac vessels. The right kidney was unusually small. The vessels to the right kidney in the region of the hilum were visualized. Other abdominal vessels were also visualized. There were no evidences of an aneurysm of the abdominal aorta.

On May 13, 1942, the pulse and blood pressure were unobtainable in the afternoon, and patient was non-responsive. Later, the abdominal aorta was palpable and pulsating. Systolic pressure was 120. The chest was clear, but the outlook grave. Patient expired at 11:45 p. m.

Post-mortem examination by Dr. M. Bevans revealed the following:

The right lung presented no specific abnormalities. The posterior aspect of the left lung was firmly adherent to and invaded by a large aneurysm of the descending aorta. Dissection of the bronchi failed to reveal any communication between the aneurysm and the bronchi. The

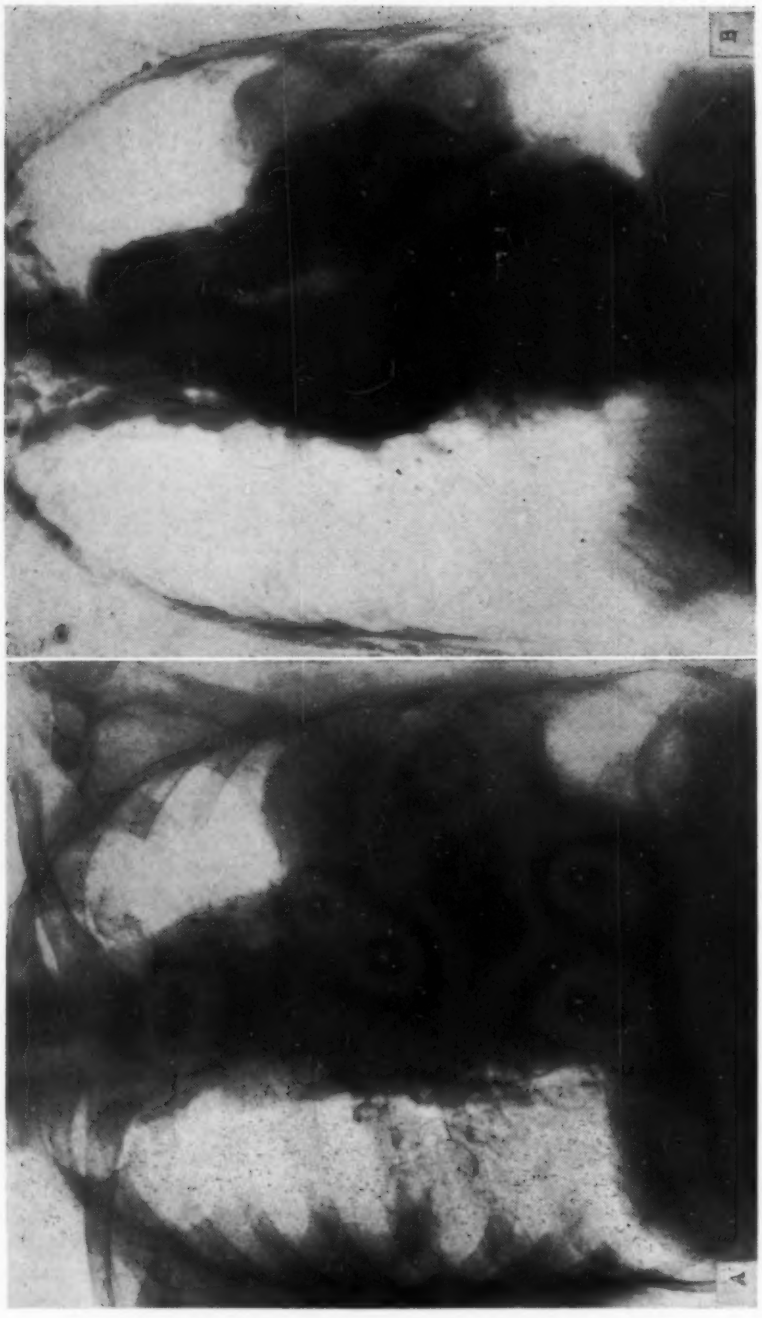

Figure 1, Female, aged 93: (A), There is a large mass in the central portion of the left chest.—(B), Angiocardiographic examination: A large aneurysm with a thick clot is visualized arising from the descending aorta.

aorta presented slight to moderate atherosclerosis in its ascending portion, there being one focal sclerotic plaque about 2 x 2 cm., just superior to the anterior aortic cusp. There was no wrinkling or "tree-barking" of the ascending aorta. The arch of the aorta began to reveal extensive atherosclerosis with ulceration and superimposed thrombus formation. This process became more marked as one examined distally, so that the descending aorta was practically completely involved by an ulcerating atherosclerosis. About 8 cm. below the arch of the aorta, extending laterally to the left and invading and compressing the posterior aspect of the left lower lobe of the lung, was an aneurysm of the aorta which measured 8 x 6 x 4 cm., and which was lined with a laminated thrombus. No communication could be traced from this aneurysm to the adjacent lung. In the lower portion of the descending aorta, just about 3 cm. above the bifurcation into the common iliac vessels, were found two small aneurysmal outpouchings, each measuring 2 x 2 cm., and each lined with a laminated thrombus.

Microscopic examination of the aorta revealed a questionable luetic aortitis.

Case 2: B. W., a colored female, aged 73, was transferred from the third (NYU) medical division of Bellevue Hospital, for diagnostic angiocardiography.

She was in fairly good health until about 8 months prior to her admission, when she suddenly became very dyspnoeic and lost her voice. Following this, she began to experience dysphagia, and was able to take liquid nourishment only. She had no episodes of vomiting. The dysphagia lasted for approximately 2 weeks. It then disappeared and she was able to eat all types of food. The patient noticed that her voice had become progressively hoarse since the onset of the dysphagia, but had improved slightly while in the hospital. Her dyspnoea was related principally to the ingestion of food and this, too, improved somewhat in the past few weeks. Her past history was non-contributory. She was married and had 2 living daughters; she admitted to having had 3 stillbirths, and 5 miscarriages. A review of systems was essentially negative, except for a non-productive cough, and slight dyspnoea on exertion. Venereal infection was denied.

The physical examination showed a fairly well developed, poorly nourished, 73 year old negress, lying propped up in bed, in no acute distress. She had a facial asymmetry, with lips pulled to the right. Her right eye was lower than the left, having the appearance of a right facial palsy. Her pupils were slightly irregular, equal, and reacted well to light and accomodation. She had bilateral nuclear cataracts. The sclera were clear, and there was no lid-lag. The fundi were not visualized, due to the cataracts. Ears, nose and mouth were essentially negative, except for carious teeth, and a deviation of the tongue to the right. The neck showed bilateral engorged veins, more marked on the right. These veins extended over the upper posterior chest, and right upper anterior chest wall. There was a small, firm, stony nodule in the left lobe of the thyroid. The trachea was slightly movable to the right, and on palpation and auscultation, revealed no thrills or bruits. There were a few shoddy cervical glands and a few small matted glands in the left axilla. Examination of the thorax revealed a kyphoscoliosis with the convexity to the right. Percussion was impaired in the upper portion of the right hemithorax. Breath sounds were diminished in this area—

there were no rales or ronchi. There was a "sensation" of a thrill in the 2nd right interspace. The remaining portion of the lungs was clear to percussion and auscultation. Examination of the heart revealed the apex beat to be in the 5th intercostal space, 8 cm. from the midsternal line. The heart was not enlarged to percussion. A_2 was greater than P_2, and there were systolic blowing murmurs at the base and apex. The apex beat was 88 and was equal to the pulse rate. The blood pressure in the right arm was 140/94, left arm 160/100. The abdomen was soft and showed marked weight loss. The liver was palpable 1 finger below the costal margin. There was right costovertebral tenderness. The extermities showed crepitation and swelling of the right knee, and clubbing of the right index finger. Neurological examination was negative except for impaired vibratory sensation.

Laboratory work revealed a sugar of 99 mgm.%; blood urea nitrogen 19.5 mgm.%; Wassermann was doubtful and Kline was positive. E K G showed a regular sinus rhythm.

The clinical impression of the mass in the right upper lung field was that of an aneurysm of the innominate artery; a teratoma and a dermoid cyst were considered as possibilities.

A roentgenographic examination of the chest revealed the following: There was a large oval mass occupying the major portion of the upper third of the right pulmonic field. The mass was situated anteriorly, sharply demarcated, compressing and deviating the trachea to the left. The lower left portion of this mass merged with the aorta. The upper portion of the mass extended to the axillary portion of the apical and sub apical portions of the chest. The heart was slightly enlarged. The aorta was sclerotic. There were calcareous plaques in the transverse portion of the arch, in the arch, and in the thoracic portion of the aorta. The thoracic portion of the aorta was tortuous.

Circulation tests prior to angiocardiography were as follows: Ether, 13 seconds; Macasol, 22 seconds; Decholin, 22 seconds; Saccharine, 23 seconds.

Angiocardiographic examination in the PA projection (Fig. 2), at the end of 10 and 22 seconds revealed the following:

Contrast substance in the right heart was faintly visualized and showed an hypertrophy of the musculature of the right heart. The pulmonary arteries were visualized. There was an extensive collateral circulation in the right clavicular, right axillary and upper mediastinal regions. The axillary vein was of normal calibre. The brachial vein was markedly reduced in size. The subclavian was irregular and tortuous. There was a loss of vessel lumen at the junction of the subclavian and superior vena cava. The superior vena cava was markedly reduced in size and showed evidences of external pressure. There was an extensive collateral circulation in the lower portion of the axilla, with communicating branches to the superior vena cava. The hemi-azygos was visualized. A collateral leading to the dome of the right diaphragm was also visualized.

At the end of 22 seconds, the left heart was completely visualized. There was no hypertrophy of the left ventricle. The aorta contained contrast substance, and its tortuosity was well visualized. In addition, there was a large circular area of contrast substance within the mass previously described occupying the upper portion of the right hemithorax, which measured approximately 7 cm. in diameter. The contrast

substance was surrounded by a fairly thick wall below and laterally, and by a thick wall above and medially.

The mass in the upper portion of the hemithorax was diagnosed as an aneurysm with a thick clot. From the location, the possibility of an aneurysm of the innominate artery was more plausible than a saccular

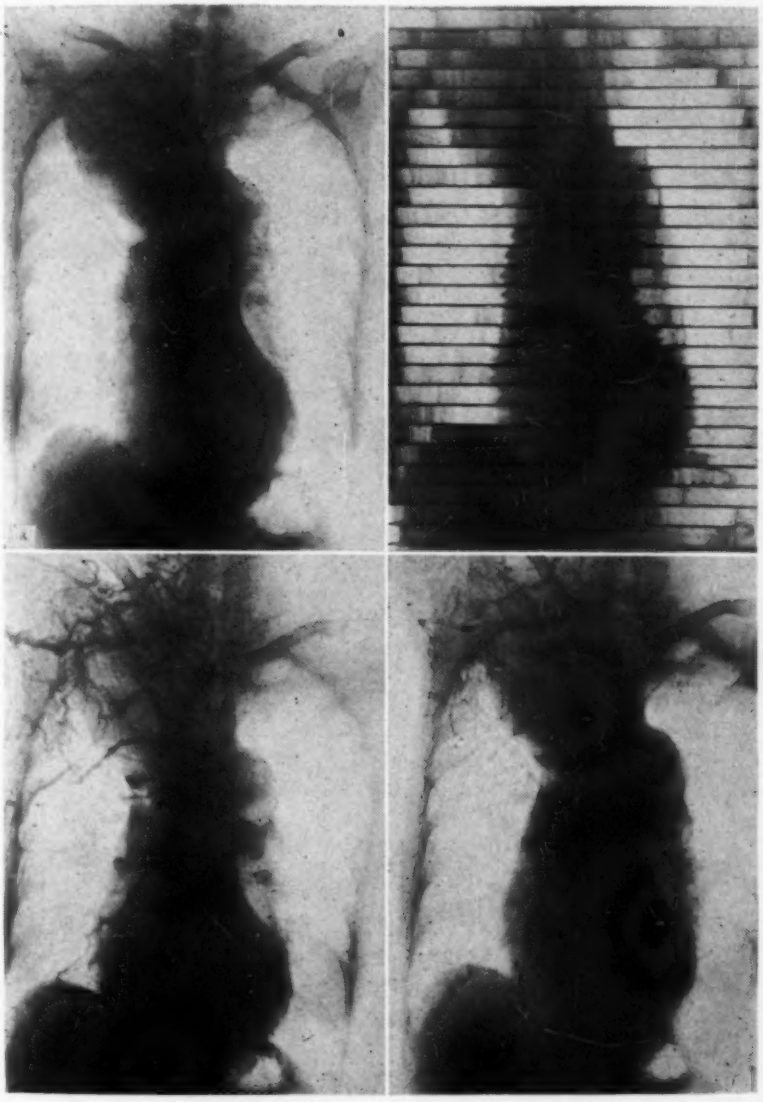

Figure 2, Female, aged 73: (A), There is a large oval mass occupying the apical and sub-apical portions of the right hemithorax, compressing and deviating the trachea to the left.—(B), Kymographic examination shows pulsations along lateral margin of mass synchronous with those of the aorta.—(C), Angiocardiographic examination: the right heart and collateral circulation are visualized at the end of 10 seconds.—(D), The left heart and aneurysm of the innominate artery are visualized at the end of 22 seconds. Verified post-mortem.

aneurysm arising from the arch. Unfortunately, roentgen studies in the oblique position were not made.

The patient was returned to Bellevue Hospital, where she died two weeks later. Post mortem examination at Bellevue Hospital revealed a luetic aneurysm of the innominate artery with thrombus formation.

Case 3: G. K., a white male, aged 45, was admitted to this hospital on March 22, 1945, with a chief complaint of epileptiform seizures for 13 years. His family history was non-contributory. He had been married for 19 years, and had 2 children, living and well. He admitted having a penile sore 10 to 15 years ago, but denied any serious illness. He travelled in the tropics, had never had any tropical disease, except for a watery diarrhea which persisted for quite a while several years ago. A number of years ago he began having dizzy spells, about 10 a day, for which he claimed to have received arm and hip injections over a long period. These attacks diminished in frequency to about once a week. During these spells he lost consciousness. Occasionally he had convulsions with severe attacks. He had no recollection of the attack when consciousness was regained. He had impairment of memory. He had no girdle or leg pains, no urinary or cardiac difficulties. There was no past surgical history, except for a T & A 19 years ago. He denied the use of alcoholics and smoked a pack of cigarettes a day.

Physical examination revealed a moderately well developed and nourished male, in no apparent distress. His eyes showed pin-point pupils which were round and equal, and did not react to light. The discs were normal. His heart was enlarged to the left in the 5th interspace, with evidences of a supra-cardiac area of dullness. The heart sounds were hyper-active, with A_2 greater than P_2. There was a loud systolic murmur over the aortic area. Blood pressure was 154/78. The abdomen revealed a scar over the right inguinal region. The remaining portion of the general examination was essentially negative. Neurological examination showed motor and sensory function intact. Reflexes were hyperactive and equal. His memory was very poor.

Laboratory findings were: Hgb. 13.6; WBC 11,000 with a normal differential; ESR 2 mm. after 1 hour; blood urea nitrogen 14.5 mgm.%; blood Wassermann 1+; BSP showed a 10% retention after 30 minutes; urine and stool negative; spinal fluid showed 1 white blood cell, was negative for ammonium sulphate; total proteins 30.6 mgm.%; Wassermann and Colloidal Gold were negative; BMR was minus 9; EKG studies were essentially negative.

A roentgenographic examination of the skull showed no abnormal findings. One of the chest (Fig. 3) revealed a mass in the supra-cardiac portion of the mediastinum to the right of the spine, and a diagnosis of an aneurysm was made. Angiocardiographic studies confirmed this diagnosis and revealed the presence of multiple aneurysm of the aortic arch, one containing a large clot.

Circulations tests prior to angiocardiography were: Ether, 3 seconds; Macasol, 12 seconds; Decholin, 13-4/5 seconds; Saccharine, 12-3/5 seconds.

Angiocardiography in the PA projection (Fig. 3) at the end of 3 and 13 seconds revealed the following: The right and left heart and large vessels were visualized in both projections. In addition, a band of contrast substance was visualized in the right paratracheal area, corresponding to the mass in the supracardiac portion of the mediastinum,

observed on routine examination. This band of contrast substance was visualized at the end of 13 seconds. The absence of contrast substance at the end of 3 seconds precluded it from being venous in origin. The upper portion of the superior vena cava was displaced slightly laterally and formed the lateral margin of the mediastinal mass. The subclavian and axillary veins were dilated.

Examination in the left oblique projection at the end of 3 and 12 seconds visualized the right and left heart and large vessels. The superior

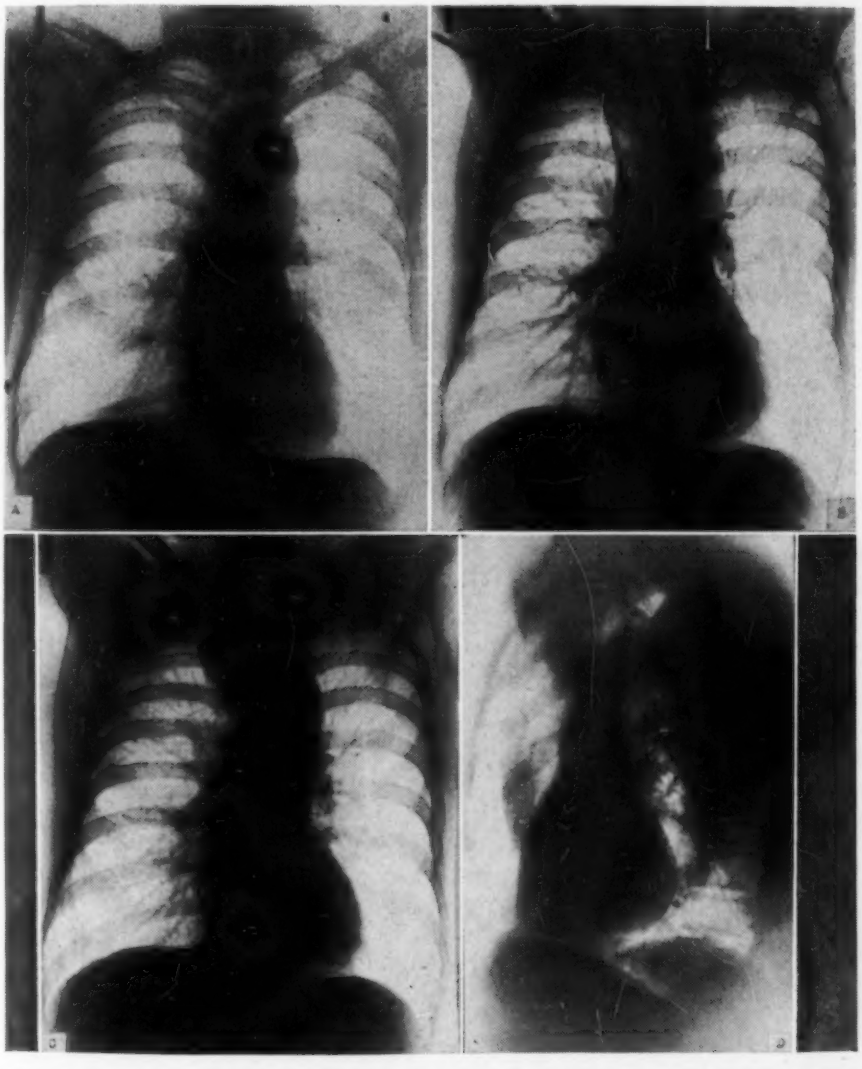

Figure 3, Male, aged 45: (A), There is a mass in the supracardiac portion of the mediastinum, to the right of the spine.—(B), Angiocardiographic examination: the right heart and large vessels are visualized at the end of 3 seconds.—(C), The left heart and aorta are visualized at the end of 13 seconds. Contrast substance is also visualized in the right paratracheal area as a band like structure which may be a tortuous and dilated innominate artery.—(D), Angiocardiographic examination in the left oblique position at the end of 12 seconds shows 3 prominences to the aortic arch: multiple aneurysms.

vena cava was dilated and displaced anteriorly. There were evidences of external pressure against the superior vena cava by an aneurysm arising from the junction of the ascending and transverse portions of the arch. The aortic arch presented three prominences; a large one with a calcified periphery containing very little contrast substance; a second superimposed aneurysm; and a third localized prominence on the upper surface of the transverse portion of the aorta. From this there extended upward a faint shadow of contrast substance, which corresponded to the broad band-like structure observed in the P-A projection.

Hospital course: Patient was inoculated with vivax malaria and after several courses received a total of 55 hours of fever over 103 degrees. The malaria was terminated with suitable anti-malarial drugs. During the course of his stay, the patient had several epileptiform seizures, with amnesia for the affair and with mild or no convulsions. For these seizures, the patient was started on dilantin and the dosage finally set at .3 of a gram a day, in divided doses. This treatment was found to definitely diminish the frequency of his seizures. He was discharged on the 66th hospital day to return in three months for a follow-up on his aortic aneurysm.

Diagnosis: Tabes dorsalis.
Multiple aneurysms of the aorta, due to syphilis.
Induced malaria.

Case 4: F. D., a colored female, aged 63, admitted from the Out Patient Department on April 19, 1945, for diagnostic angiocardiography, who, when first seen at the clinic on March 14, 1945 complained of pain over the abdomen and shoulders. The patient stated she was well until about 1 year ago, when she had pneumonia. During the early part of last year, she first started having pains, which were fleeting in nature, noted principally across her chest, back, neck, and in her abdomen. Because of this, she stated, she was admitted to Harlem Hospital on May 25, 1944, and a transcript from this hospital revealed that a diagnosis of coronary thrombosis was made. A roentgenographic examination of the chest at that time showed a bulge of the left ventricle. She was treated conservatively and discharged on June 23, 1944 from Harlem Hospital. Since her discharge, she had a "sick feeling," especially in bad weather, which became progressively worse. A review of systems was essentially negative, except for a slight hacking cough, some dyspnoea on moderate exertion, and frequent skipping of the heart.

A routine fluoroscopic examination of the chest at the clinic revealed a bulge of the left ventricle, and it was decided to determine if this were a ventricular aneurysm by angiocardiography.

Physical examination revealed an elderly colored woman, in no acute distress. Her pupils reacted to light and accommodation. Ears, nose and throat were essentially negative. Chest was clear to percussion and auscultation. Examination of the heart revealed a normal rate and rhythm. There was no enlargement to percussion. No murmurs were heard. Blood pressure was 120/80. Examination of the abdomen was essentially negative.

Laboratory work revealed the following: RBC 4.59; Hgb 83%; WBC 4.8 with a normal differential; ESR 31 mm. per hour, and 15 mm. per hour; blood urea nitrogen 14.4 mgm.%; sugar 95 mgm.%; Urine, negative; Wassermann and Kline, negative; EKG revealed severe myocardial damage and intraventricular block.

A roentgenographic examination of the chest (Fig. 4) disclosed no infiltration or consolidation, no pleural effusion and no tuberculosis. The heart was enlarged; the axia transverse; the shape oval; and the configuration was that of an aortic or hypertensive type heart. In addition, there was a localized prominence to the left ventricular border due to a ventricular aneurysm. This was verified by angiocardiographic studies. Kymographic examination showed no characteristic ventricular pulsations at the site of the bulge in the left ventricular border.

Circulation tests prior to angiocardiography were: Ether 5-1/4 seconds; Decholin 13-4/5 seconds; Saccharin 12-1/2 seconds; Macasol 13 seconds.

The following cases illustrate non-vascular lesions:

Case 5: A. A., a white male, aged 58, was admitted to this hospital on November 3, 1944 with a complaint of loss of weight, weakness, tiredness and persistent cough of 6 months duration. In October of 1939, while walking downstairs, he noticed that his knees were weak. He returned to bed and the next day found his legs were swollen, especially at the joints and that he was unable to move them. His arms and elbows were similarly involved. He was taken to Morrisania Hospital, where he remained for 2 months, and was told that he had had a "rheumatic attack". He returned home and remained in bed for seven months until his legs were strong enough to support him. His present illness began 6 months ago, when despite an enormous appetite he began to lose weight. His weight dropped from 160 to 140 pounds. He became weak, progressively more tired, slightly dyspnoeic, and at night slept with 3 pillows to relieve his cough. At night he felt hot and perspired a great deal. He had no chest pain and was not aware of any glandular enlargement. On November 2, 1944, he was admitted to Metropolitan Hospital. There it was found that his WBC was 400,000, with over 90% lymphocytes. He was transferred to this hospital on November 3, 1944. His family history was non-contributory. A review of systems revealed that he had had a cough for 20 years. Coughing spells occurred mostly at night and produced a teaspoonful of a whitish-yellow sputum during an episode. He had no history of hemoptysis, chest pain, night sweats or weight loss. He was told that he had bronchial asthma. However, he never had a frank asthmatic attack, and never received any type of injection. He had been taking variously colored capsules over a period of years. He never had pneumonia, but did take cold easily. In 1936, and again in 1943, he stated, he had gonorrheal infections. He denied a luetic history.

Physical examination revealed a poorly nourished, middle-aged man, in no acute distress. He was somewhat dyspneic. He had a right corneal opacity. His left pupil reacted to light and accommodation. His ears, nose and throat were essentially negative. He had markedly enlarged, discrete, rubbery glands in the anterior and posterior cervical, subaxillary, axillary and inguinal regions. His chest was emphysematous, hyper-resonant, and breath sounds were increased, particularly during the expiratory phase. Inconstant, scattered rales were heard throughout both lung fields. The cardiac borders were not percussable. The point of maximum intensity was heard in the 5th interspace at the midclavicular line on the left. Heart sounds were of fair quality, and the first sound was split at the apex. A_2 was greater than P_2, and there

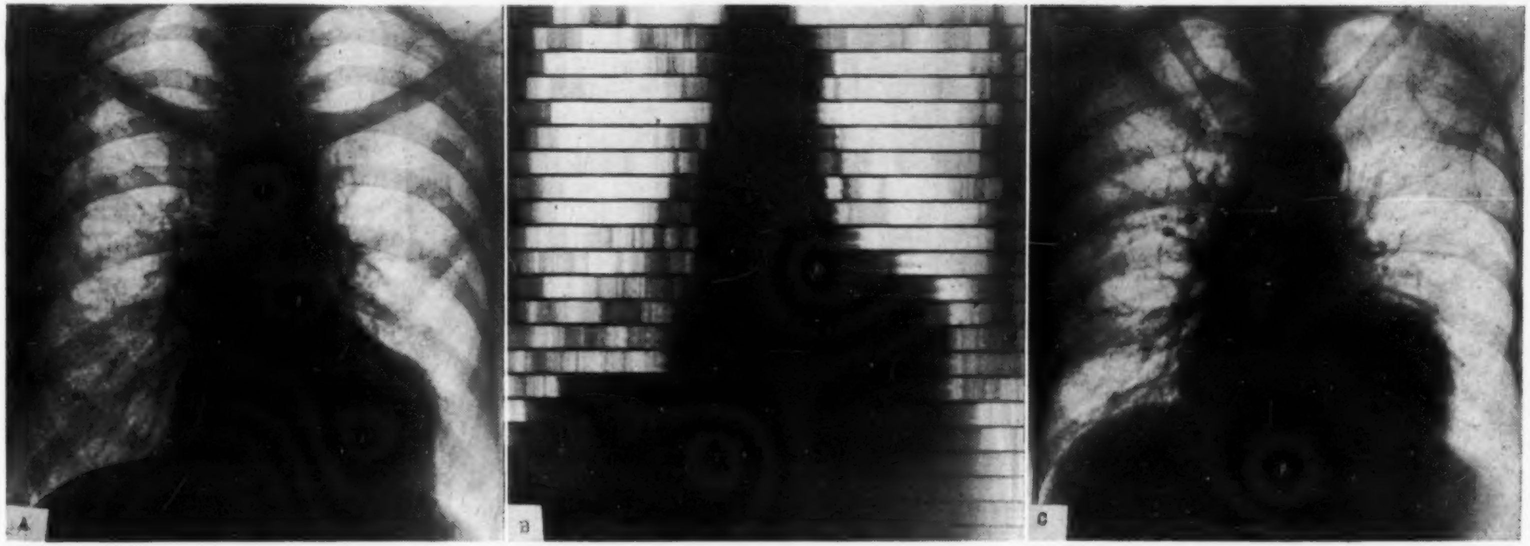

Figure 4, Female, aged 63: (A), There is a prominence to the basal portion of the left ventricular border: ventricular aneurysm.—(B), Kymographic examination shows a loss of ventricular pulsations in the area corresponding to the site of the bulge in the ventricle.—(C), Angiocardiographic examination: the left heart and aorta are visualized at the end of 12 seconds. A ventricular aneurysm is visualized.

were no audible murmurs. His pulse rate was 78. Blood pressure was 125/84. Examination of the abdomen revealed the liver edge to be firm, smooth and tender, and it was palpable 4 cm. below the costal margin. The remaining portion of the physical examination was essentially negative.

Laboratory findings revealed the following: RBC 3.9; Hgb 79%; ESR 16; WBC 370,000 with 95% lymphocytes; blood urea nitrogen 25.8 mgm.%; uric acid 4.4 mgm.%; urine 1+ albumin; urine concentration test 1027; Bence-Jones test negative; BMR +37; Wassermann and Kline were negative; EKG showed mild myocardial damage.

A roentgenographic examination of the chest (Fig. 5) on November 6, 1944, revealed a large mediastinal and paravertebral mass on the left side merging with the aortic shadow and not differentiated from it. It

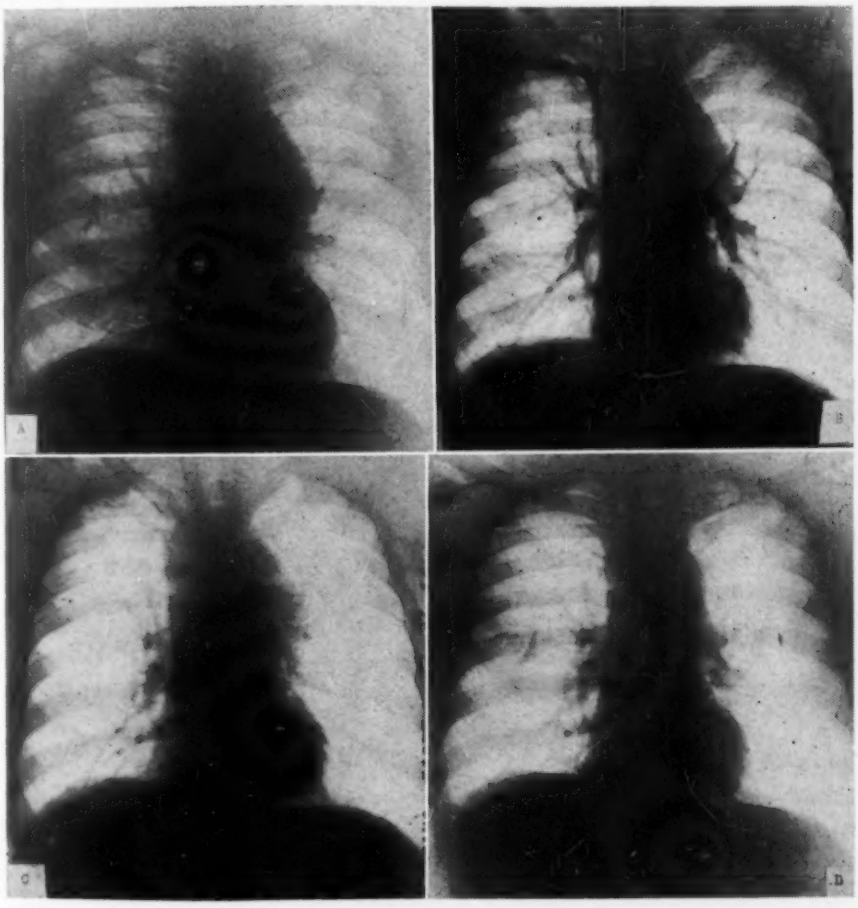

Figure 5, Male, aged 58: (A), Large mediastinal and paratracheal mass, left side, merging with the aorta, and differentiated from it.—(B), Angiocardiagraphic examination: the right heart, pulmonary aorta, right and left, pulmonary arteries, pulmonary vessels and superior vena cava are visualized at the end of 3 seconds.—(C), The left heart and aorta are visualized at the end of 10 seconds. There is no contrast substance within the mass in the superior mediastinum; it is non-vascular.—(D), Marked regression of mediastinal mass following radiation therapy: chronic lymphatic leukemia.

was felt this might be enlarged nodes or an aneurysm. Oblique views a short time later did not distinguish the origin of this mass.

Course: On November 14, 1944, 11 days after admission, the patient began receiving roentgen therapy to the spleen. After 4 treatments, his WBC had dropped to 66,000. Clinically during this period the patient was in excellent spirits and had no complaints. He gained 3 pounds. His spleen, liver and lymph glands had not appreciably changed since admission. The radiation therapy was terminated on November 27, 1944. At this time the WBC was 66,000; RBC 3.45; Hgb 61%. Several days later the patient began to cough and was dyspneic. On December 8, 1944, his count was 400,000 with 95% mature lymphocytes. Radiation therapy was again instituted and on December 22, 1944, his WBC was 13,000 with 69% lymphocytes. There was no change in the appearance of the paratracheal mass.

On December 27, 1944, angiocardiographic studies were made, without ill effects and revealed the following:

Angiocardiographic examination in the PA projection (Fig. 5) at the end of 3 seconds, visualized the entire right heart, pulmonary aorta, right and left pulmonary arteries, and several pulmonary vessels, as well as the superior vena cava. The right heart was not enlarged. The upper surfaces of the right and left pulmonary arteries showed evidences of pressure from a mass in the superior mediastinum. At the end of 10 seconds, the left heart and aorta were visualized. The left heart was not enlarged. The musculature of the left ventricle measured approximately 8 mm. in thickness. The aorta was outlined within the mass in the superior mediastinum. The mass within the superior mediastinum contained no contrast substance, except for that within the aorta. Examination in the left oblique projection at the end of 9 seconds showed contrast substance in the left heart and aorta. The left auricle was visualized, as well as the vessels leading into it. The lumen of the ascending aorta measured approximately 4½ cm., while the transverse and descending portions measured 2½ cm. The large vessels leading from the aortic arch were visualized. There was no contrast substance within the mass. There was a slight fusiform dilatation of the ascending aorta. The large mass in the superior mediastinum did not fill with contrast substance; it was not vascular in origin.

The patient was discharged with a WBC of 20,000. He had gained 4 pounds; his cough and dyspnea had improved, and the lymph nodes throughout his body had decreased in size. There was no change in the size of the spleen.

The clinical improvement did not last. He was readmitted to the hospital in March and again in July, because of dyspnea, fatigue and generalized enlargement of nodes.

Case 6: M. H., a white female, aged 46, a registered nurse by profession, was referred by Dr. Louis R. Davidson for angiocardiographic study because of the presence of a mass in the upper and anterior mediastinum. She had always enjoyed good health. Twelve years ago she had had a normal BMR. Ten years ago, while in the Public Health Service, in the course of an annual examination, she had had a kymographic and roentgenographic examination of the chest; these were reported as normal. She was married 16 years ago; had one child; living and well. There is no previous surgical history.

During the past winter she had a laryngitis. Recently the patient

developed a cough which she thought was due to a sinus infection; this was followed by a wheeze. A roentgenographic examination of the chest revealed a large mass in the anterior superior mediastinum which extended to either side of the mid line. The trachea was compressed and deviated to the left. Other laboratory data revealed a normal EKG, and a −7 BMR.

Circulation tests were: Ether, 3 seconds; Macasol, 10 seconds; Decholin, 9½ seconds; Saccharine, 10 and 12 seconds.

Angiocardiographic examination (Fig. 6), revealed the following: The heart and large vessels were opacified in the PA and LAO projections at the end of 3 and 10 seconds. No contrast substance opacified any portion of the mediastinal mass, and therefore it was considered as non-vascular in origin.

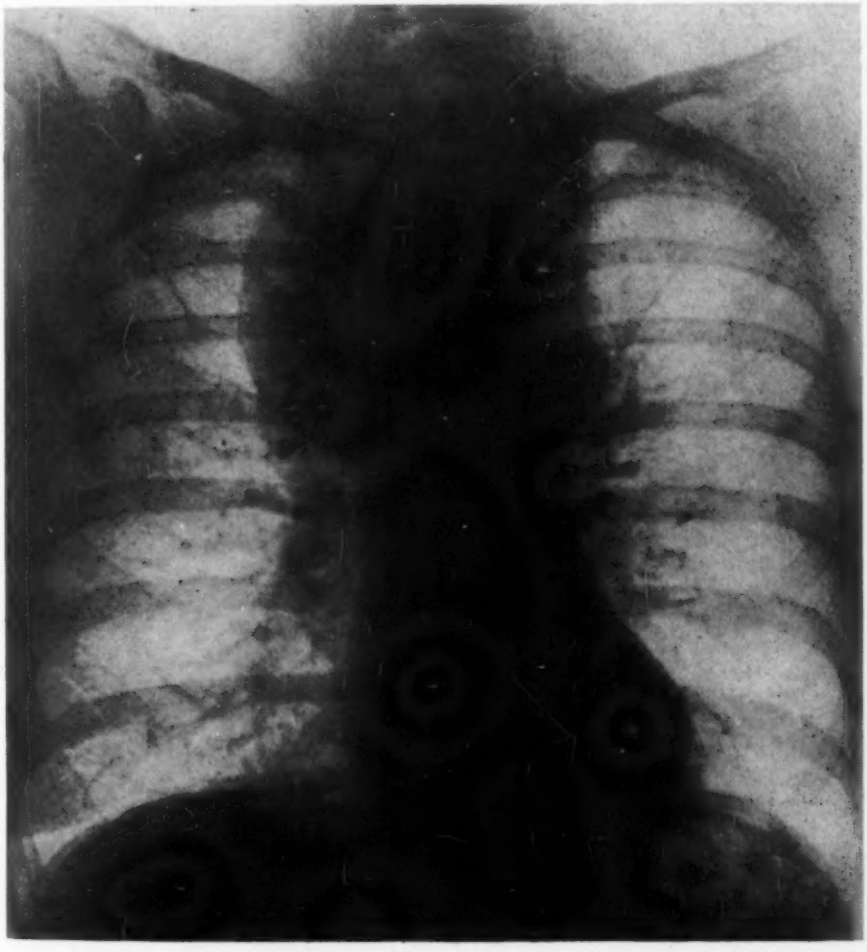

Figure 6, Female, aged 46: There is a large mass in the superior mediastinum compressing and deviating the trachea to the right. The mass extends to either side of the mid-line, down to the aorta. Angiocardiographic examination at the end of 3 and 10 seconds failed to show any contrast substance within the mass: it is non-vascular. Surgery was instituted and the mass proved to be a retro-sternal thyroid.

Surgical intervention and excision of the mass by Dr. Louis R. Davidson proved it to be a large retrosternal thyroid.

SUMMARY

Six cases with angiocardiographic studies are illustrated: One with a cardiac lesion, two with non-vascular and three with vascular lesions. The cases illustrate a left ventricular aneurysm; two nonvascular mediastinal lesions: a retrosternal thyroid, and a chronic lymphatic leukemia; an aneurysm of the innominate artery; an arteriosclerotic aneurysm of the descending aorta; and multiple aneurysms of the aortic arch.

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RESUMEN

Se ilustran seis casos con estudios angiocardiográficos: Uno con una lesión cardíaca, dos con lesiones no vasculares y tres con lesiones vasculares. Los casos ilustran un aneurisma del ventrículo izquierdo; dos lesiones mediastínicas no vasculares: una glándula tiroides retro-esternal y una leucemia linfática crónica; un aneurisma de la arteria innominada; un aneurisma arterio-esclerótico de la aorta descendiente; y aneurismas múltiples de la curvatura de la aorta.

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The Bearers of Shadows

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MASS FLUOROGRAPHY

In 1917, in Paris, during the first World War, I was studying in the tuberculosis dispensary of the Laennec Hospital, then directed by Dr. E. Rist. I was very young and inexperienced then, but the circumstances of the moment, as well as the association of a double curiosity in my mind—the study of physics and medicine—led me to think in 1918 of the possibility of fluorography, so as to obtain small documents of very low cost, permitting the x-ray examination at the dispensaries.

After a long stay in Paris, from 1914 to 1922, I returned to Rio de Janeiro, where I intended to fully realize my career. The problem was that of the diagnosis of tuberculosis and of cardiovascular affections which had to be done in the early stages and on a large scale. I resumed in Rio, in the Superintendency for the Prophylaxis of Tuberculosis, newly created by Placido Barbosa, the experiments interrupted in Paris, and in 1924 I obtained some fluorographic negatives. However, it was still too early. I did not succeed in emerging from the experimental stage. But, already at that time, the miniature radiograph and its vast social application, seemed to me to be the only solution to the problem of the mass diagnosis of apparently healthy persons.

At last, in 1935, I came back to systematic fluorography. The luminous slides of calcium tungstate, lens of 1-1.5 aperture, linear cathode tubes and the photographic emulsions of 28° Scheiner, included the necessary condition for the realization of an idea of my youth—the radiographic examination of population groups. I constructed a frame in the shape of a truncated pyramid, fixing the camera in its smaller base, and at the larger one the fluoroscopic screen. The complete frame slid between four columns. It was the first micro-radiographic apparatus which I exhibited in 1936 to the Medical Society of Rio and Sao Paulo. The negatives measured 35 and 40 mm. The clearness and the contrast were good, obtaining a favorable report from the Brazilian Society of Tuberculosis, which recommended the adoption of the new method.

In February 1937, I inaugurated the first Survey Center in the Rio Public Health Department, based on the 35 mm. fluorography; it was intended for social groups of apparently healthy individuals. In the same year the Central Navy Hospital and the Public Health

Department of the city of Victoria also inaugurated identical services.

The Tuberculosis Congress of Santiago, Chile, in 1937, contributed in a decisive way towards the knowledge and universal use of fluorography, for several European and American specialists, when passing through Rio, visited my installations at the Public Health Department, where about 200 examinations were being made daily.

Great tenacity and confidence were needed by my early collaborators and myself to overcome a traditional reluctance to accept the new method. The dispensaries used to receive the patients when it was already too late, and the advanced tuberculosis no longer responded to the treatment. Those patients had come to the end of their career as spreaders of the infection, so that the prophylatic function of the dispensary was almost nil. This conception of the individual and late diagnosis, practically useless, was in opposition to that of the early and mass diagnosis. Besides, the fluorographic negatives, although excellent, were not well accepted from the start owing to their small dimensions. It was found necessary to carry out a vast campaign from 1937 onwards, with the collaboration of several friends, among whom I must mention Clemente Ferreira, A. de Paula, F. Benedetti, S. Neves, P. Cortes, G. Ribeiro, A. Lopes (Brazil); E. Mazzei, G. Sayago, Rodolfo Vaccarezza, Raul Vaccarezza (Argentine Republic); J. Morelli, L. Sayet, P. Purriel, A. Piaggio (Uruguay); and during this campaign I lived the best days of my life.

Then there occurred a complete transformation in the attitude of the scientists with regard to the fight against tuberculosis. The idea of the systematic and periodical examination of whole population groups, formerly considered as a visionary conception, acquired the force and beauty of a simple truth. And the movement against tuberculosis took the following course—the early discovery of affected persons in the first phase of the evolution of tuberculosis, when treatment appears to be efficacious and when isolation protects the community.

BEARERS OF SHADOWS

But the adoption of the systematic and periodical examination by means of fluorography, discovering bearers of shadows in the lungs, frequently during the initial period of tuberculosis, has come to prove that the bacteriological examination according to customary techniques is not entirely satisfactory. A large number of problems appear with serious consequences. Are we dealing with evolutive or residual tuberculosis? Should we induce pneumothorax or should we wait? In the case of an employee or worker should he be employed, be given leave of absence, pensioned off

or not? Should a health certificate be granted or not? The presence of the bacillus in the sputum constitutes thus the indispensable complement to the radiographical examination, without which there can be no etio-pathogenic or evolutive diagnosis.

In order to solve such a distressing problem, phthisiologists are resorting to the examination of the sputum and the gastric lavage. The former requires the presence of sputum in sufficient quality and quantity; being generally useful in cases of pulmonary tuberculosis in frank evolution, often largely excavated. The latter presents great variations, and in patients affected with active tuberculosis can be repeatedly negative. Indeed, the presence of the broncho-alveolar secretion in the fasting stomach varies in proportion to several factors which render the above mentioned examination deficient and laborious.

LOCALIZED TOMOGRAPHY

Based on these considerations and being the director of a Diagnosis Revision Committee, which handles numerous cases demanding a rapid and accurate solution, I thought of using in all the *bearers of shadows* the *localized tomography*. I do not tomograph the whole chest, but only the places where there are shadows, in films of small size, 9 x 12 and 13 x 18 cm., sometimes 24 x 30 cm. Generally, 3 sections are enough, at the depth of 7, 9 and 11 cm.

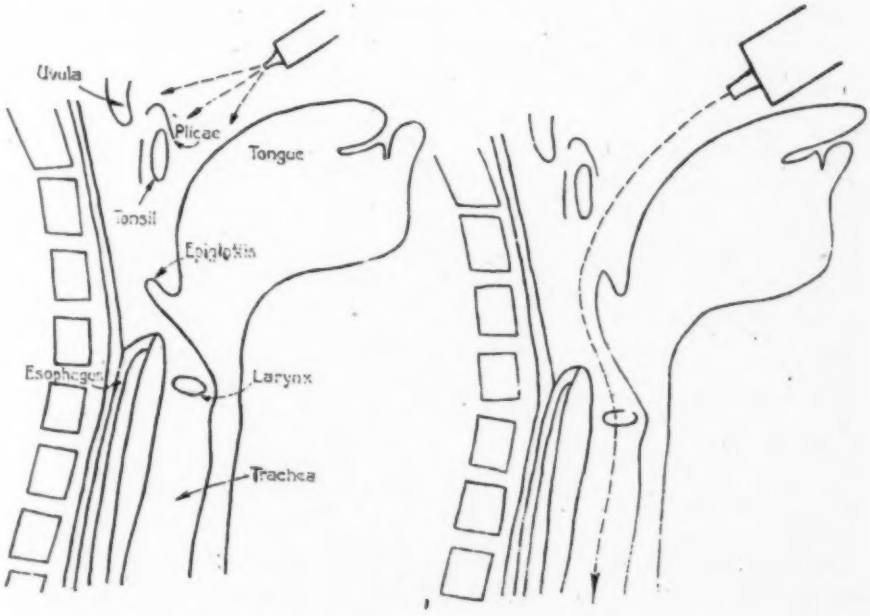

Figure 1 *Figure 2*

Fig. 1: Technique of the supra-glottic anaesthesia: uvula, tonsil, plicae and pharynx.—*Fig. 2:* Infra-glottic anaesthesia during inhalation: larynx, trachea and bronchi. Lung lavage with physiological saline.

from the posterior surface of the thorax. The localized and systematic tomography seems to me very important for studying the structure of lesions, and can easily make the diagnosis of cavities (invisible in the usual type of radiograph), calcareous or fibro-calcareous lesions that represent indurated fields without activity, nodules and closed infiltrations more or less organized, in which activity is absent or very low, atelectasis, and alveolar infiltrations or exudative processes that seem to be active.

Figure 3

Figure 3A

Figs. 3 and 3A: Fibro-calcareous lesions, well visible in the tomogram. Lung lavage negative for Koch bacili.

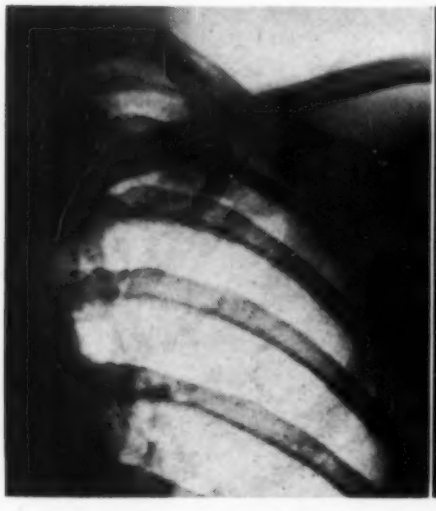

Figure 4

Figure 5

Fig. 4: Discrete early infiltration under the clavicle. Lung lavage positive.
Fig. 5: Discrete and chronic lesions in the apex, stabilized during one year. Lung lavage positive.

LUNG LAVAGE

At the same time, in ill patients without expectoration or with scant expectoration negative for the Koch bacilli, I use a new method, the *lung lavage* or *tracheo-broncho-alveolar lavage*, which I think is the solution of the problem of demonstrating the elimination of bacilli.

The technique of the *lung lavage* is as follow: 1) Anaesthesia of the supraglottic region with 1 to 2 cc. of a 0.5 per cent solution of novotutocain. The anaesthesia should be applied slowly with a small syringe of 2 cc. capacity. 2) Slight traction and fixation of the tongue and infra-glottic anaesthesia, during inhalation (1 to 2 cc. of the same solution). 3) Injection, under the same condition, from 10 to 20 cc. of physiological saline during inhalation. 4) Provoke cough and collect secretion or material for examination.

ACTIVE AND INACTIVE TUBERCULOSIS

Undoubtedly, the aim of the revision is to ascertain as quickly as possible the category of the patient, in accordance with the following classification:

Non-tuberculous affection.

Inactive tuberculosis.

Active tuberculosis.

In the case of a non-tuberculous affection, a diagnosis should be arrived at and this has been done in several instances (emphysema, air cysts, congenital bronchiectasis, other pneumopathies, cardiovascular affections, etc.).

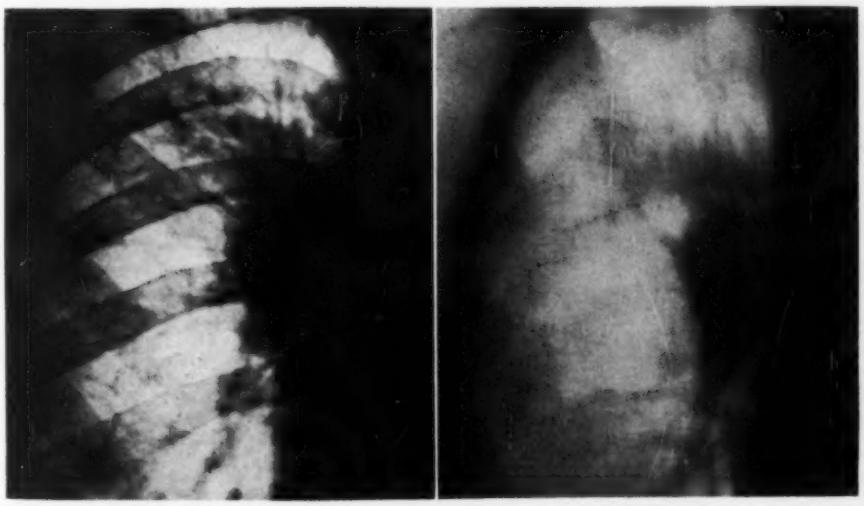

Figure 6 *Figure 6A*

Figs. 6 and 6A: Primary affect with erythema nodosum. Lung lavage positive.

The activity or evolutive potential of tuberculous lesions is reflected in the clinical symptomatology, in radiographic figures and in bacteriological data. The last two seem to us to be the most important, principally in view of the culture and inoculation into the guinea pig of the material collected by the lavage. Besides, I have observed perfect harmony between radiography and bacteriology. In 3 cases only the radiographic image has appeared relatively larger while the bacteriological test was negative. This apparent disagreement should be cleared up by prolonged observation of the patients, who are cases of closed tuberculosis or of non-tuberculous affections, such as blastomycosis. Cases of tomographic diagnosis of a cavity with a small diameter diagnosed by tomograms, have revealed positive lavage. Also one case of primary form in an adult (primary affect and erythema nodosum) had revealed positive lavage.

Generally speaking, the fibrous forms, accompanied by calcareous impregnations, were negative to the bacteriological examination. On the contrary, the exudative and excavated forms were positive.

Another important point is the following: the majority of positive cultures presented very few colonies, sometimes one or two in five tubes; it concerned patients with a paucity of bacilli and with several previous negative examinations. The aforesaid circumstance demonstrates the efficiency of the lung lavage, followed by a thorough bacteriological test.

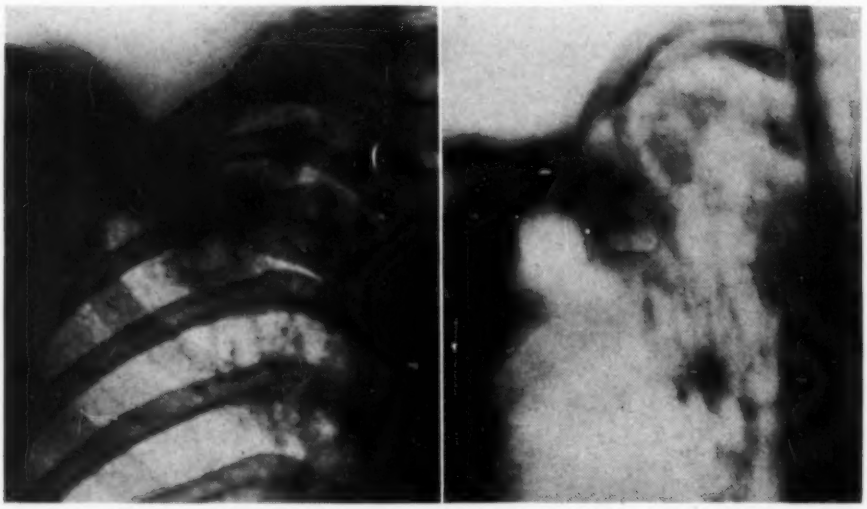

Figure 7 *Figure 7A*

Figs. 7 and 7A: Infiltration and cavity, better seen in the tomogram. Lung lavage positive.

BACTERIOLOGY

Direct examination, culture on Loewenstein medium and guinea pig inoculation, are systematically made. The culture and the inoculation are indispensable, especially in forms of tuberculosis without sputum or with a negative one. In 32 positive lavages for the Koch bacillus, the following was observed:

Direct examination	5 — 15.62%
Culture	22 — 68.75%
Inoculation	5 — 15.62%
Total	32

Thus, the direct examination, not homogenized, was positive few times because of the small number of bacilli. In about 70 per cent of the cases the culture revealed the presence of the bacilli, only a few colonies appearing in each tube. Lastly, in approximately 16 per cent of the lavages, only inoculation proved conclusive.

In three of the cases of positive direct examination, innumerable negative tests had been made in the usual manner, including the gastric lavage.

STATISTICS

To date, 450 lung lavages have been performed. Of these, 313 cases have completed the time limit necessary to obtain final

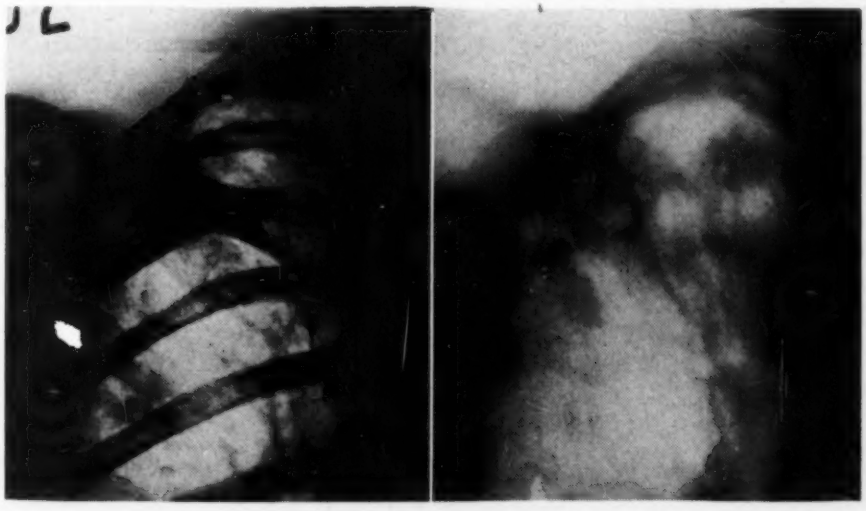

Figure 8 *Figure 8A*

Figs. 8 and 8A: Exudative form. Cavity visible only in the tomogram. Lung lavage positive.

results of cultures and inoculations of guinea pigs. These first statistics reveal the following results:

Lung lavage in individuals without sputum or with negative sputum (313 original cases):

	Number	*Negative*	*Positive*
Suspected	176	160	16 — 9.09%
Patients and ex-patients	137	105	32 — 24.87%
Total	313	265	48 — 15.33%

It is a well-known fact that the number of positive cases varies greatly. In our first 42 lavages we had 33.33 per cent; in the last 38, however, this was reduced to 7.9 per cent. The presence of the bacillus depends on the human material, being more frequent in patients under treatment or clinically cured, but rarer in suspected persons who are bearers of discrete shadows, revealed by systematic x-ray examination.

A comparative study of the lung lavage and that of the stomach has been made. Dr. R. Fernandes made these tests on the same day, on 18 apparently cured patients, at the Miguel Pereira Hospital. Here are the original results:

	Stomach	*Lung*
Negative	17	10
Positive	1 — 5.55%	8 — 44.44%

Figure 9

Figure 9A

Figs. 9 and 9A: Exudative form. Cavity visible only in the tomogram. Lung lavage positive.

We emphasize the following fact: the patients appeared to be clinically cured, and in addition, the gastric lavages were performed with exacting skill, that is, during hospitalization.

We are indebted to our colleagues F. Magarao, J. Dauster, R. Fernandes, G. Ribeiro and Machado Junior for their invaluable collaboration in this work.

CONCLUSOES

O autor mostra a evolucao da fluorografia sistematica no diagnostico da tuberculose pulmonar, iniciada em 1936, oficialisada no inicio de 1937, no Rio, depois, a partir de meados de 1938, divulgada na Europa e America. Descreve o movimento inspirado pelo novo metodo em que a medicina, de estatica e tardia, passou a ser dinamica e oportuna, procurando os doentes ocultos na massa coletiva.

Os *portadores de sombras* apresentam lesoes pulmonares cuja atividade precisa ser esclarecida. Neste momento, devido ao exame sistemático, sao numerosos os casos de sombras que correspondem a processos—residuais ou, ao contrário, em plena evolucao. Sao indivíduos clínica e socialmente normais ou doentes. Nestes será necessário aplicar o tratamento e o isolamento convenientes.

Em todos os portadores de sombras o autor emprega a tomografia localizada para o estudo da estrutura anatomo-radiológica, assim como o lavado pulmonar para a pesquisa do dacilo de Koch. Descreve os resultados da tomografia localisada e a tecnica do lavado pulmonar, mais simples e mais eficiente que o lavado gastrico, no adolescente e no adulto. Mais de 500 casos de tuberculose aparentemente inativa foram examinados da referida maneira pela Comissao de Diagnóstico, sendo a incidencia da tuberculose evolutiva nos mesmos de 15.33%.

Complemento indispensável dos postos de exame sistemático pela fluorografia, sao os laboratórios centrais de radiologia e bacteriologia, dotados de aparelhagem e pessoal capazes de realizar numerosas tomografias, culturas e inoculacoes em cobaia. O problema da atividade das lesoes pulmonares tem hoje amplitude social e requer instalacoes novas e eficientes.

Neurogenic Tumors at the Pulmonary Apex

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Since Pancoast's report in 1924 and again in 1932[11] of seven cases of an intrathoracic tumor occurring at the pulmonary apex and to which he gave the name of superior pulmonary sulcus tumor, neoplasms in this particular area have attracted the attention of roentgenologists, clinicians and pathologists. Pancoast's suggestion that this tumor was a new entity, probably having its origin from an embryonic remnant of the fifth branchial pouch soon was challenged and as cases accumulated it became evident that the syndrome described by him (tumor in the pulmonary apex associated with rib or vertebral destruction, pain around the shoulder and down the arm and Horner's syndrome) could be produced by a variety of malignant neoplasms, most of which were primary carcinomas of the apex of the lung.[2,4,12]

The interest in these malignant tumors has overshadowed to some extent the fact that growths of a benign nature, mostly neurogenic in origin, show a distinct tendency to develop in this same location. In the literature most of these have been described as of mediastinal origin since they are prone to originate from the intercostal nerves close to the spine or from the para-vertebral ganglionic chain in the posterior mediastinum. As the tumor enlarges it protrudes into the lung field and its chief clinical and roentgenological manifestations may be pulmonary rather than mediastinal. Perhaps it would be better to speak of these as intrathoracic rather than mediastinal since they usually do not remain confined to the mediastinal space even though originating there. Also those that develop from the intercostal nerves may be found at some distance from the spine although this is not common.

TYPES OF TUMORS AT THE PULMONARY APEX

It is possible, as Ray[12] suggests, to postulate innumerable kinds of tumors in the region of the pulmonary apex. In his review of fifty collected cases of malignant lesions, among those having autopsy studies there were 15 carcinomas of the lung primary in the apex, 2 squamous cell carcinomas of branchial origin, 1 sympathicoblastoma, 3 epithelial carcinomas of unascribed origin, 1 metastatic carcinoma from the pancreas and 1 metastatic carcinoma from the esophagus.

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The incidence of all benign intrathoracic tumors is low and most of these are found in the mediastinum or along its borders. In Blades[1] review of collected cases there were 233 cases of teratoid tumors, all but three of which originated in the anterior mediastinum. The next most frequent tumors were those of the neurogenic group, of which there were 135 reported cases, the majority arising in the posterior mediastinum or along its margins. All of the remaining types were rare and were listed as follows:—fibromas, 32 cases (some of which may have been neurofibromas); tumors arising from bone or cartilage, 14 cases; intestinal cysts, 15 cases; lipomas, 34 cases; xanthomas, 5 cases.

Among the benign tumors likely to occur in or along the pulmonary apex there is general agreement that the neurofibromas and allied neurogenic tumors are by far the most common.[1,3,9] The histological classification of tumors arising from the nerves and ganglia is complex and controversial and is beyond the scope of this report. Regardless of the exact cell type, the potentiality for malignant degeneration seems to be present in all. According to Fischer,[5] in a review of collected cases, the incidence of malignant degeneration in neurofibromata was 13 per cent. Recognizing this possibility, the clinical diagnosis of an intrathoracic neurogenic tumor carries with it the chance that malignant changes may be revealed on microscopic examination.

CLINICAL FEATURES

The benign intrathoracic neurogenic tumors as a group show a tendency to develop to a considerable size without significant symptoms until encroachment upon or displacement of some vital structure ensues. This is true of those occurring at the pulmonary apex as well. Discovery often is accidental upon roentgenography of the chest for some other cause or merely as a routine study. When symptoms do develop pain in the chest and cough are common.[10] Harrington[8] lists dyspnoea as the most frequent symptom in his series. In those tumors limited to the pulmonary apex, and in marked contrast to the malignant tumors in this region, the occurrence of a Horner's syndrome and of pain radiating down the arm has been described but rarely. Schaffner et. al.[13] reported one such case, the lesion upon removal proving to be a neurofibroma. In Harrington's series of 14 cases of intrathoracic neurogenic tumors, one patient had a Horner's syndrome and this proved to be the only malignant tumor in the series. Not all were located in the lung apex, however. The clinical signs of involvement of the paravertebral ganglionic chain are more indicative of a malignant lesion than of a benign one, although this cannot

be considered as an absolutely reliable differential diagnostic point. The neurogenic tumors show no age or sex predilection.

ROENTGEN FINDINGS AND DIFFERENTIAL DIAGNOSIS

The tumor mass is visualized on roentgen examination of the chest as a sharply circumscribed, homogeneous shadow of variable size located at the summit of the pulmonary apex or along the medial aspect of the apex. The inner margin tends to merge with the mediastinal shadow although with properly exposed roentgenograms, the entire circumference of the mass may be visualized. Stereoscopic views, when the tumor is small, together with lateral and oblique projections, show the mass to be located posteriorly and in close association to one or more of the upper ribs and the spine. Larger tumors fill the apex completely and may extend below the anatomical apex so that their posterior origin can no longer be determined. These larger masses may also displace the esophagus and trachea, the smaller ones do not. No destruction of bone is evident although a pressure type of erosion of one or more ribs may be present especially if the lesion is large. At the junction of the mass and the apical or mediastinal wall an acute but smooth sulcus may be formed suggesting a stripping or reflection of the pleura over the mass. It is important that the roentgen examination be thorough, so that the relationships of the lesion and the condition of the adjacent bony structures be determined.

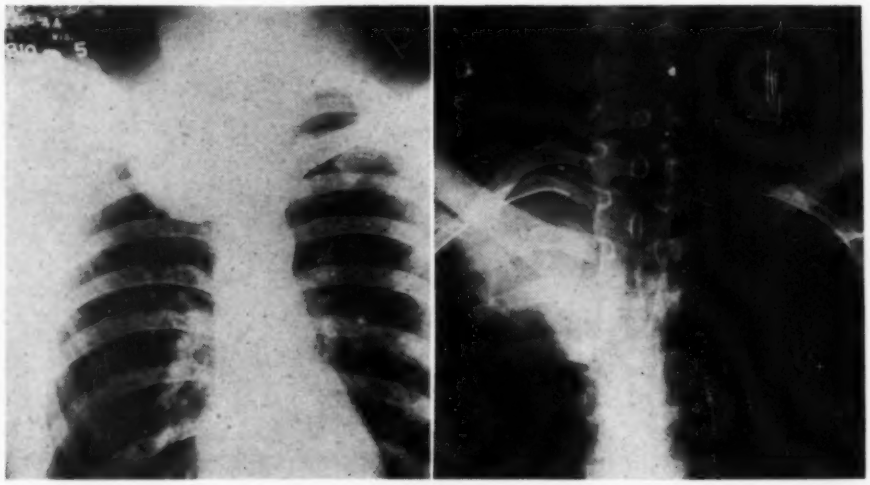

Figure 1 *Figure 2*

Fig. 1, Case 1: Roentgenogram of the chest showing a large circumscribed mass in the right apex. This was discovered on a routine admission photofluororoentgenogram.—***Fig. 2, Case 1:*** Potter-Bucky film to show bone detail. There is no involvement of the ribs or vertebrae. The trachea is displaced slightly to the left of the midline.

At first glance the differential diagnosis of these tumors seems complex. Yet actually there are relatively few lesions that need to be considered. The differentiation from malignant tumors in this area (the superior pulmonary sulcus tumor of Pancoast) is perhaps the most important. These latter tumors are inoperable, usually radioresistant and carry a hopeless prognosis. In contrast the benign neurogenic tumors, and even those that show microscopic evidence of malignancy, usually are amenable to surgical removal. Ray[12] goes so far as to suggest that all tumors at the apex of the lung, even though all the evidence indicates that they belong to the Pancoast syndrome, should be explored surgically on the chance that an occasional neurogenic tumor might be encountered and found operable. The malignant neoplasms cause rib and/or vertebral destruction in the vast majority of cases although this may not happen until late in the disease. This destruction has the characteristic "melted ice" appearance seen with invasion of bone by carcinoma. In Pancoast's cases it began

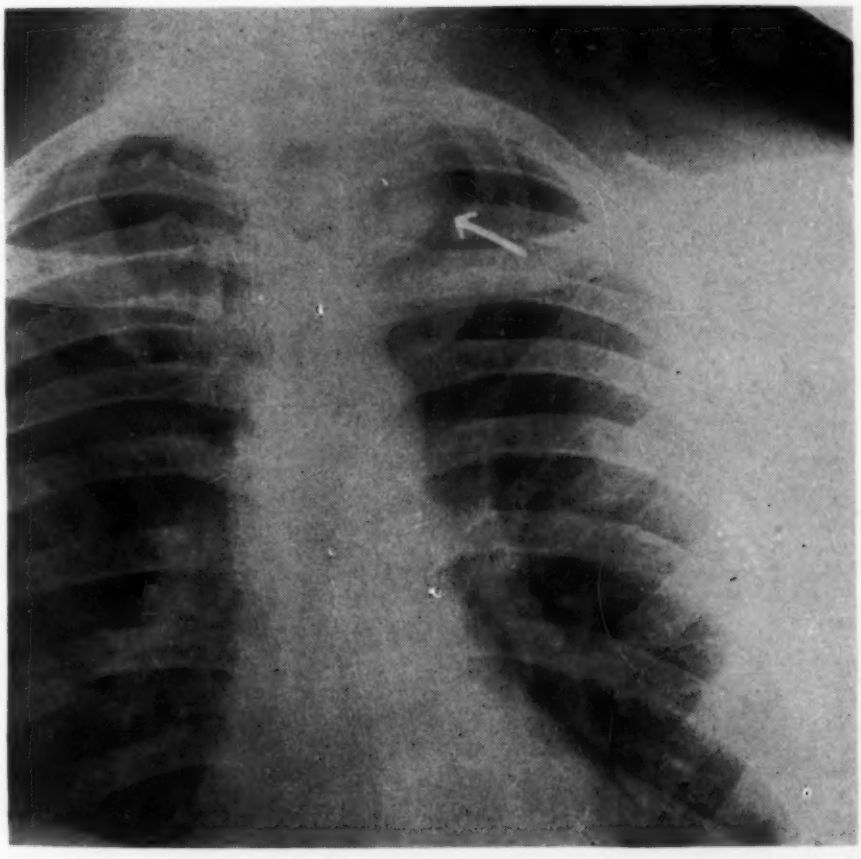

Fig. 3, Case 2: Small mass along medial aspect of left apex. There is no rib or vertebral erosion.

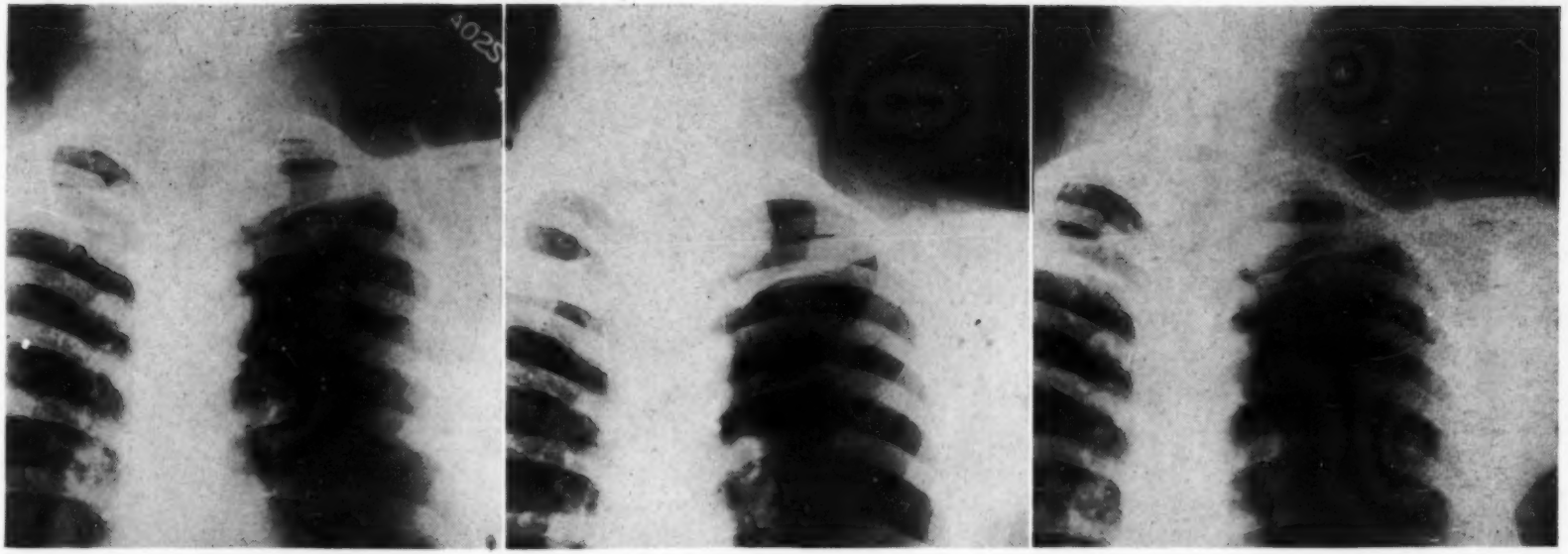

Figure 4A *Figure 4B* *Figure 4C*

Fig. 4, Case 3: (A), Employees routine roentgenogram, 11-6-40. Small circumscribed tumor mass along medial aspect of left apex. This was present in a chest roentgenogram in December, 1937, but had increased in size since then.—(B), One year later (11-3-41). Slight increase in size.—(C), Eight months later (7-21-42). No visible change. Final observation (5-13-43) by photoroentgenogram showed no apparent change.

in the first rib in four, and in the second and third in two others. The rib involvement began from three to nine months after the onset of symptoms. In the series reviewed by Ray (fifty cases) some bone destruction was present in the neighborhood of the tumor in 90 per cent. The most outstanding symptoms in these cases were due to irritation or damage of the upper intercostal nerves, the brachial plexus and thoraco-cervical sympathetic ganglionic chain. These symptoms were, almost without exception, the first to appear and the most prominent throughout the course of the disease.

A comparison of the roentgenographic images of these malignant tumors and those of benign nature reveals some significant differences. A study of our own cases and of those illustrated in the literature shows, in the malignant lesions, a much less distinctly outlined shadow. In some the shadow was very hazy and small and could easily be missed on casual inspection. Yet these minute lesions could be responsible for severe clinical symptoms. This is in marked contrast to the benign growths which are sharply circumscribed, show no bone invasion and which may develop to a large size before symptoms appear.

There are a number of causes for soft tissue shadows in the region of the pulmonary apex including enlarged thyroid and substernal extensions of the thyroid, tumors of the thyroid and thymus, neoplasms of the paratracheal and anterior mediastinal

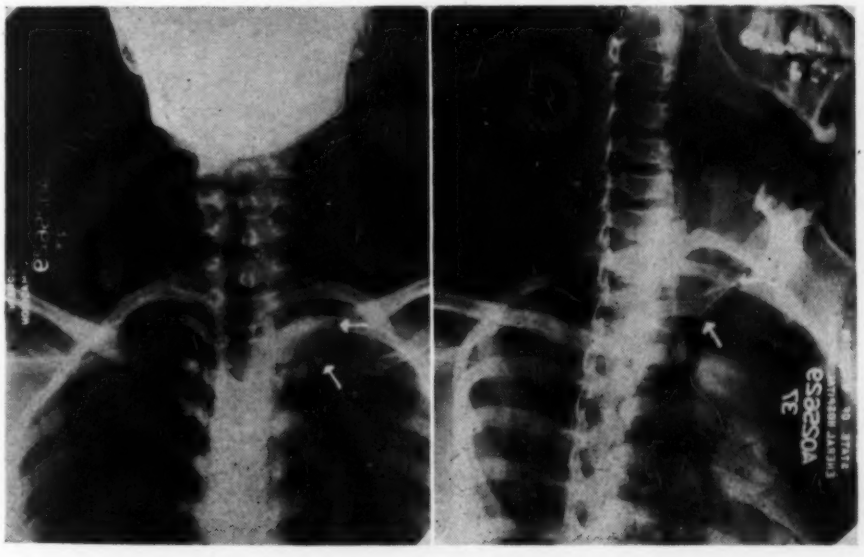

Figure 5A *Figure 5B*

Fig. 5, Case 3: (A), Bucky film AP view. No rib erosion. Pedicle shadows intact.—(B), Oblique projection demonstrates the mass to be posteriorly in close association with the second rib.

lymph nodes, aneurysms of the vessels arising from the aortic arch, tortuous and sclerotic innominate and subclavian arteries, and tumors arising from the ribs, vertebrae, clavicles or sternum. Most of these can be recognized readily by their appearance and location, the presence of pulsation in the case of vascular lesions, movement upon swallowing in the thyroid enlargements and the character of bone changes in those arising from bone. None of them produce quite as sharp, distinctly outlined and circumscribed a mass as the neurogenic neoplasms. Diagnostic pneumothorax can be utilized if necessary to show the extrapleural nature of the tumor. Solitary metastasis especially from the kidney or testicle must also be considered. It should be possible to demonstrate the primary tumor in most instances. If lymphoblastoma is a serious consideration, test doses of radiation may be given to determine the radiosensitivity of the tumor. Primary tumors of the pleura are rare. The same is true of other benign tumors which might be found along the upper posterior mediastinum. None of these can be excluded with certainty except on the basis of statistical probability. The teratoid tumors occur almost exclusively in the anterior mediastinum and somewhat away from the apical area. Other congenital cysts are found usually in the central mediastinum.

TREATMENT

The treatment of these tumors is surgical. They are almost entirely radioresistant and radiation therapy has little to offer. Surgical removal is indicated even though the tumor is small and asymptomatic because of the inherent tendency for malignant degeneration, the probability of increase in size making later removal difficult, the always present possibility of malignant change having already begun in a neoplasm which is grossly benign, or because of a mistaken diagnosis.

CASE REPORTS

Case 1: (L. J.). This was a 29 year old white male admitted to the hospital with chief complaints of weakness and tiredness present off and on for the past four years but which had been worse the last four weeks following the extraction of two teeth. There had been a weight loss of about eight pounds. There was a slight hacking cough with the raising of very little sputum. He also complained of night sweats and difficulty in getting to sleep. Physical examination showed nothing remarkable, routine laboratory studies were within normal limits and neurological examination showed nothing abnormal. A routine photofluorographic admission film demonstrated a tumor mass at the apex of the right lung confirmed by further studies (Figs. 1 and 2). On further questioning after the discovery of this mass the patient said that he had been told that he had such a tumor following an x-ray examination of the chest nine years previously. He also had noticed

that he sweated only on the left side of the face, neck and upper chest and not on the right and that he had been aware of this for the past six or seven years. Surgical excision of the tumor was decided upon and after some difficulty, because of its size, the entire tumor was removed. It weighed 236 grams. The histologic diagnosis was neurofibroma. Postoperative convalescence was uneventful except that following operation a Horner's syndrome appeared on the right side and was still present at the last examination two months later. Otherwise the patient had no complaints and had gained six pounds in weight.

Comment: The relationship of this patient's symptoms and the tumor is questionable although Harrington[8] was impressed by the frequency with which patients with intrathoracic neurogenic tumors complained of chronic exhaustion and fatigue. The lesion was too large to determine whether it had originated from the posterior aspect of the apex or not but all of the other findings pointed to a benign growth including the history of nine years' duration, and the preoperative diagnosis was neurofibroma. The development of a Horner's syndrome immediately after operation was due probably to injury of the adjacent ganglia during the operative procedure.

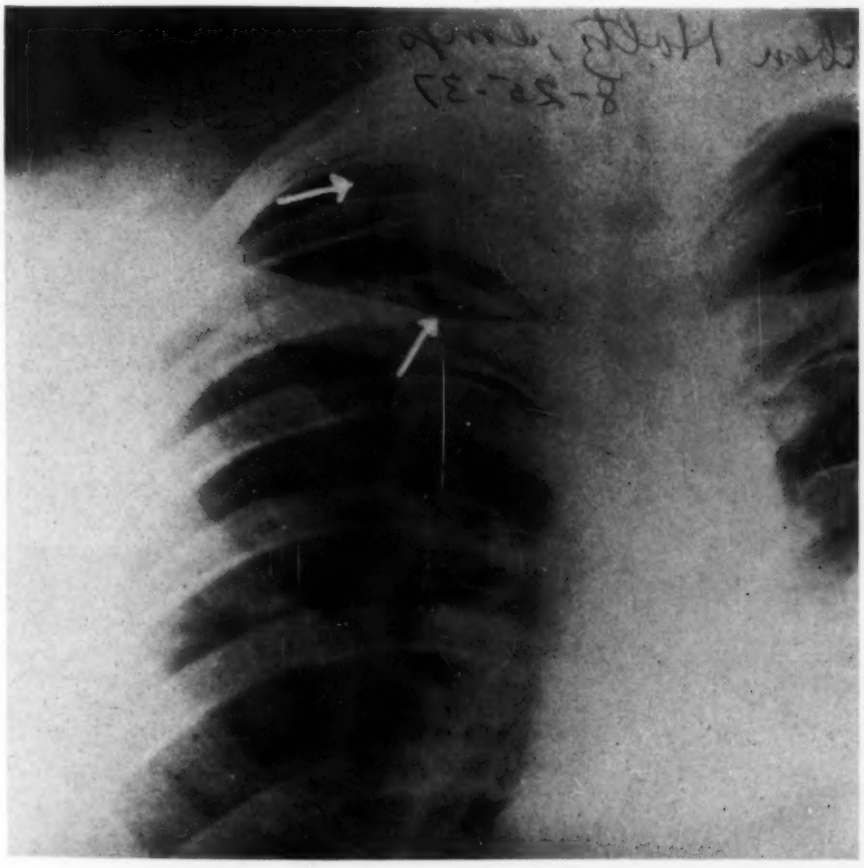

Fig. 6A, Case 4: Employee's original roentgenogram of 8-25-37. Small circumscribed mass in right apex.

Case 2: (H. M.). The patient was a white male, 35 years of age, admitted to the hospital on October 4, 1943. About 7 months prior to admission, he first noticed some dizziness which had continued more or less constantly. Soon afterwards he developed a dull feeling over the right side of the face and ringing in the right ear. During the last month there had been a decrease in hearing in the right ear. There had been a weight loss of 20 pounds. On physical examination a slight prominence of the right eyeball was found. The neurological findings included hypesthesia of the second and third divisions of the right fifth nerve, diminished corneal reflex on the right, taste absence on the anterior two-thirds of the tongue on the right, absent abdominal reflexes, knee jerk diminished on the right, and nystagmus more marked on gaze to the right. Audiogram showed a marked deafness on the right. Routine blood, urine and spinal fluid studies were normal. A routine chest roentgenogram revealed a small tumor mass at the left apex (Fig. 3). A diagnosis of right cerebello-pontine angle tumor was made and the lesion in the chest was considered to be a neurofibroma. On surgical exploration of the right cerebello-pontine angle region a fungating tumor mass was found penetrating deeply. A small biopsy

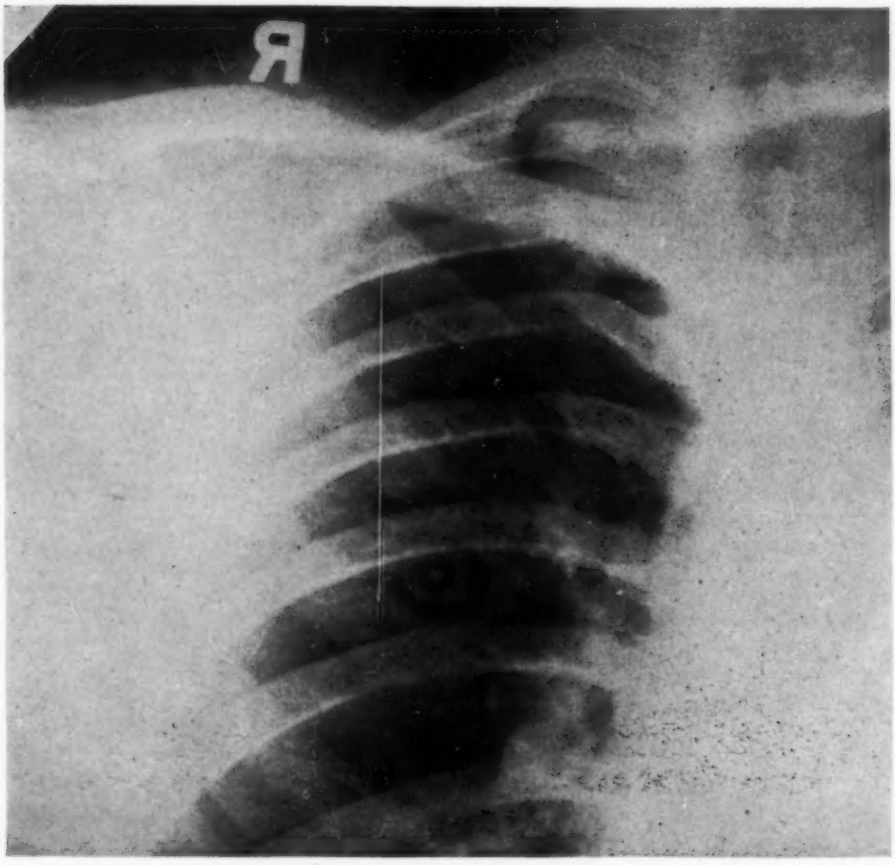

Fig. 6B, Case 4: Three and one-half years yater (1-28-42). No apparent change in size.

was taken and on frozen section was reported as adenocarcinoma and nothing further was done surgically. However, on study of the fixed sections the pathologist reported no tumor tissue present and stated that the tissue was normal choroid plexus. The possibility of the chest tumor being a primary lung carcinoma then was considered. After some discussion it was decided to explore this small tumor since it was felt that some light might be shed on the problem and biopsy of or removal of this mass was considered less hazardous than another craniotomy. Should the lesion have proved to be a lung carcinoma, no further surgical measures on the brain tumor would have been necessary. Accordingly, removal of the chest tumor was done without difficulty. It was reported to be a neurofibrosarcoma of a low-grade of malignancy. Further brain surgery was deferred for the time being. The patient was discharged and has not returned for further study.

Comment: We are still uncertain as to the relationship of the two tumors since the biopsy report on the brain lesion was not helpful. As the majority of cerebello-pontine angle tumors are neurogenic, this may have been one, the small amount of tissue removed not being representative of the tumor itself. The chest lesion was asymptomatic

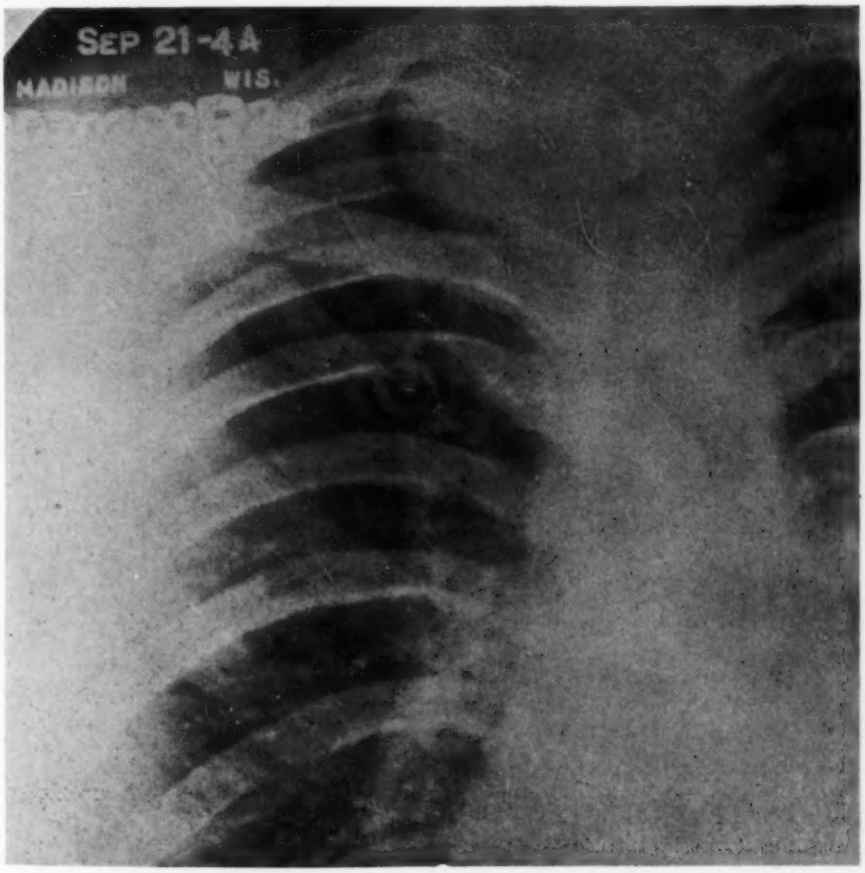

Fig. 6C, Case 4: Final roentgenogram of 9-21-44 (Seven years after A). No change in size.

and of small size yet showed evidence of a low-grade of malignancy. This case emphasizes the importance of early removal of even small neoplasms of this nature since there was nothing in its gross appearance to indicate malignancy.

Case 3: (V. W.). This patient was a 36 year old white female nurse who had a routine employees chest roentgenogram at this hospital for the first time in November, 1940. This demonstrated a small amount of granular infiltration in the right apex and a small, circumscribed mass along the medial aspect of the left apex (Fig. 4A). Investigation of her past history revealed that she had had an intracranial tumor, said to be an acoustic neurinoma, removed nine years previously. Recovery ensued within a year and there had been no symptoms relative to this since. The patient had no complaints at the time of this examination. Since her chest had been roentgenographed while she was an employee elsewhere in 1937, this roentgenogram was obtained. It showed the mass to have been present at that time although only about half as large. Subsequent roentgen examinations were made at intervals, the last on 5/13/43. A slight increase in size of the tumor occurred during this period of observation (Fig. 4B and 4C). At the last clinical examination on January 15, 1943, the patient felt entirely well. Surgical removal of

Fig. 7, Case 4: Oblique view showing posterior location of mass adjacent to second and third ribs.

the tumor was considered but the patient did not desire it and operation was deferred (Figs. 5A and 5B).

Comment: While histological study of this tumor has thus far not been possible, all of the evidence indicates that it is of neurogenic origin. The prior operation for an acoustic nerve tumor is of interest in this connection. The multiple occurrence of neurofibromata is well known. Roentgen examination covering a period of six years was available so that the slow growth of the tumor could be followed.

Case 4: (R. H.). This patient was a 32 year old white male, an attendant at another hospital who had a routine employee's chest roentgenogram in August, 1937. It revealed a small tumor mass in the right apex. No detailed physical examination record is available but there were no symptoms from the lesion and he continued to work; subsequent chest roentgenograms were taken in February, 1938; May, 1942; September, 1942, and the final one in September, 1944. During this period of seven years the mass remained stationary in size and appearance (Figs. 6 and 7).

Comment: The roentgen appearance of this lesion, its location and lack of appreciable growth all indicate a benign tumor and it is probably a neurofibroma or similar tumor. The patient has not been desirous of having it removed so that the diagnosis has not been proved.

SUMMARY AND CONCLUSIONS

Neurogenic tumors form a distinct group of intrathoracic neoplasms and are found chiefly along the mediastinal borders. The benign tumors of this class are second only in frequency to the teratoid tumors. A favorite site of development appears to be at the pulmonary apex with the tumor arising from one of the upper intercostal nerves close to the vertebrae.

Clinically these neoplasms cause little in the way of physical signs or symptoms until they become large enough to produce pressure on adjacent structures. The possibility of malignant degeneration is always present and therefore surgical removal is recommended once the diagnosis has been reasonably well established.

Roentgenologically the tumor shadow is sharply circumscribed, rounded or ovoid in shape and located along the medial aspect of the pulmonary apex or at the apical summit. Pressure erosion of ribs or vertebrae may exist but invasive destruction is not seen.

Two cases are reported in which operative removal of the tumor was done. One was a neurofibroma and the other a neurofibrosarcoma of a low grade of malignancy. In addition two other cases are described with similar roentgen findings which were observed over periods of six and seven years respectively but without histological proof of the diagnosis.

Differentiation from the malignant tumors of the pulmonary apex causing Pancoast's syndrome (usually carcinomas of the

lung) is important and is possible when all of the clinical and roentgenologic factors are carefully considered.

RESUMEN Y CONCLUSIONES

Los tumores neurógenos forman un distinto grupo de neoplasmas intratorácicos y se encuentran principalmente a lo largo de los bordes del mediastino. Los tumores benignos de esta clase sólo le van en zaga en frecuencia a los tumores teratoides. El ápice pulmonar parece ser un sitio favorito de desarrollo, con el origen del tumor en uno de los nervios intercostales superiores, próximo a las vértebras.

Desde el punto de vista clínico estos neoplasmas causan pocos signos físicos o síntomas hasta que lleguen a ser lo suficiente grandes para producir presión sobre las estructuras adyacentes. Existe siempre la posibilidad de degeneración maligna y, por lo tanto, se recomienda la extirpación quirúrgica tan pronto como el diagnóstico se haya establecido razonablemente bien.

Desde el punto de vista roentgenológico la sombra del tumor aparece claramente circunscrita, de forma redondeada u ovoide y situada a lo largo del aspecto medio del ápice pulmonar o en la cúspide del ápice. Puede existir erosión de costillas o vértebras debido a presión, pero no ocurre la invasión destructiva.

Se informa sobre dos casos en los que se llevó a cabo la extirpación quirúrgica del tumor. El uno fue un neurofibroma y el otro un neurofibrosarcoma de bajo grado de malignidad. Se describe también otros dos casos con hallazgos roentgenológicos semejantes que fueron observados por períodos de seis y siete años, respectivamente, pero sin prueba histológica del diagnóstico.

Es importante diferenciar estos tumores de los tumores malignos del ápice pulmonar que causan el síndrome de Pancoast (generalmente carcinomas del pulmón) y esto es posible cuando se consideran cuidadosamente todos los factores clínicos y roentgenológicos.

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Intrathoracic Metallic Foreign Bodies

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There is an extensive literature dealing with the immediate problems, both diagnostic and therapeutic, of penetrating injuries of the thorax, but only a rather sparse amount of information on the *late* behaviour and appearance of intrathoracic metallic foreign bodies.[2,4,5,12,13] In view of the large number of persons who have survived in the recent world conflict with such bodies still retained, it may be timely to review the roentgen findings in a fairly large group of cases, and to consider the detailed data concerning a small number of them.

Surgical textbooks devote very little space to the general subject of pulmonary metallic foreign bodies, or else approach it almost exclusively from the aspect of aspirated objects. For example, in Christopher's well-known book[4] appears the statement, "Retained foreign bodies introduced from without should be removed, because otherwise they give rise to rapidly spreading infection and result in lung abscess, gangrene, empyema and suppurative mediastinitis." Since no mention is made as to whether the author is referring to aspirated or penetrated foreign bodies, the reader may reasonably assume that he means both. In Lewis' Practice of Surgery (1944)[12] there is an extensive amount of data on aspirated foreign bodies in the thorax, but very little on the subject of penetrating objects.

DIAGNOSIS AND CLASSIFICATION

The diagnosis of intrathoracic metallic foreign bodies is usually based on the history, the presence of a scar and, sometimes, on the clinical findings. The history is occasionally misleading, since the patient may have sustained merely a glancing injury to his thorax and the fragment may be subcutaneous in location. The presence of a scar is valuable evidence, but it is to be noted that the absence of one is not exclusive; some sharp, smooth objects such as small calibre bullets may penetrate the thorax and leave virtually no visible wound of entry.[9] If such object also leaves via the thoracic cage, the wound of exit is, of course, apt to be larger and much more readily visible. The clinical findings in the early stages are well-known; those in the late stages are apt to be

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The opinions set forth in this article are those of the writer and not to be considered as reflecting the policies of the Navy Department.

minimal, except when the patient has been the victim of complicating infection or is aware of the fact that he has a retained projectile.[1]

The essential feature in the diagnosis of intrathoracic metallic foreign bodies is naturally the roentgen examination. It should consist of roentgenography in at least two planes (postero-anterior and lateral films, with fairly heavy penetration), followed by such additional projections as are indicated to confirm the location of the object or objects. Tangential "spot" films are especially useful in determining whether the missile lies within or without the lungs. Fluoroscopic examination is essential in many cases, especially with objects near the rib cage or the diaphragm. Heavy penetrated stereoscopic projections are often of value; tomograms may be necessary in some cases to determine the exact location of the fragments, especially if the patient has complicating pulmonary or pleural densities, and there is a question of juxtaposition to certain large bronchi.

Intrathoracic metallic foreign bodies may be classified in accordance with various factors such as number, size, location and so forth. Almost all of them are opaque, despite the extensive use of aluminum in aircraft and similar equipment. From the point of view of the clinician, the important facts regarding foreign bodies are, of course, the presence or absence of associated bleeding and infection, and the amount of nonmetallic material (bone splinters, clothing and other debris) driven in at the time of injury. However, from the point of view of the roentgenologist as well as that of the subsequent compiler of accurate surgical or medical records, we believe that the following data should be made available:

1. Number of opaque foreign bodies;
2. Size,
3. Shape, and
4. Position thereof.
5. Changes (not necessarily related) in adjacent structures:
   a. Pulmonary and pleural structures,
   b. Diaphragm,
   c. Thoracic wall — (soft parts and bones),
   d. Mediastinum,
   e. Heart and pericardium.
6. Movement: the movement of bodies, especially those near large cardiovascular areas should be studied fluoroscopically and recorded.
7. Other foreign bodies: adjacent areas such as the neck, shoulders and abdomen should be scrutinized, and the presence or absence of opaque bodies therein noted.

Many cases disclose multiple metallic foreign bodies; in such, only the size of the larger ones or those which are suspected as having potential clinical significance need be recorded. The shape is worth recording since jagged objects are apt to have more associated traumatic and infectious changes than smooth ones. The study of movement in connection with bodies is most important in those lying in or close to the heart and great vessels. However, fluoroscopic examination is always of value, since the existence of some metallic fragments which had been concealed by motion in the roentgenograms may thereby be revealed. Occasionally the problem of differential diagnosis between calcified nodes and metallic foreign bodies arises: in such cases also fluoroscopic examination is of value.

The nature and extent of residual pulmonary changes are often obscured by overlying pleural thickening. Fine scar tissue tracts may be visible in one film and not in another. Some metallic foreign bodies, notably slender, smooth, sharp-pointed ones, may migrate. Bullets and larger fragments will occasionally lie free in the pleural space; we have seen two cases in which considerable doubt arose as to the veracity of previous reports merely because roentgen examination had been made at one station with the patient erect and at another with him horizontal; the bullet lay at the apex one time, and at the base of the pleural cavity the second.

In connection with the classification of the exact type of foreign body present, the x-ray findings are often not characteristic. Even the personal and clinical data on these cases is difficult to evaluate. Many individuals frankly admit they do not "know what hit them"; others are quite positive that it was a sniper bullet, or a grenade or so forth; the roentgenogram may reveal a jagged piece of metal, later identified by an ordnance expert as something of quite different nature from that which the victim felt sure had hit him. In the stress of emergency medical care many wounds are labelled "gun shot wounds" and this term clings to the patient's record, despite the fact that it was produced by shrapnel, mortar, shell or grenade fragment, or by pieces of metal from nearby objects.[8*]

LOCALIZATION

The simplest means for the localization of the vast majority of intrathoracic metallic foreign bodies is ordinary teleroentgenographic examination in two planes (usually P. A. and lateral),

*In the African campaign (1941-43) Nicholson and Scadding encountered the following retained foreign bodies in a series of 291 cases of penetrating chest wounds: bullet 24, shell 131, mine 10, bomb (mostly mortar) 51.

supplemented by tangential or stereoscopic views as indicated. Should there be any medical or surgical indication for removal of the foreign body, the patient may be placed under the fluoroscope in the same position that he will occupy on the operating table and the exact location of the body marked on the skin in two planes, at right angles to each other. The simplest method is to use a sterile needle and place small scratch marks on the skin which will survive subsequent preoperative preparation. Other methods include the subcutaneous injection of a little dye, the insertion of sterile clips or needles and so forth.

Should associated injuries or other considerations prevent placing the patient in two different planes, various other methods of localization including stereoscopy, parallax, triangulation and so on may be resorted to. In actual practice these are rarely necessary in connection with the types of case reviewed in this paper (See Table I).

TABLE I

Location of *Removed* Intrathoracic Metallic Foreign Bodies (Recently Reported)

Location	*Nicholson and Scadding*	*d'Abreu et al.*	*Tuttle et al.*
Pulmonary	7	25	44
Pleural	14	14	..
Diaphragmatic	..	..	..
Mediastinal	5	4	5
Endothoracic Fascia	..	4	..
Cardiac	1	..	..
Pericardiac	..	3	3
Vertebral Body	1	..	..
TOTAL	28	50	52

ROENTGEN FINDINGS

The late roentgen findings in relation to intrathoracic metallic foreign bodies are quite variable. Some patients who have had severe penetrating through-and-through injuries of the chest, with a sucking pneumothorax, etc., may have one or two residual intrapulmonary fragments and no other significant changes; scarring may be so minimal that it is only visible in the most perfect of stereoscopic roentgenograms.[9,15] On the other hand, a small jagged fragment which happened to sever an intercostal

or other artery, and was followed by extensive intrapleural or extrapleural hemothorax, secondary infection, pleural fistula and so forth, may be associated with advanced pulmonary and pleural scarring, etc. The changes incidental to hemorrhage and infection constitute the main factor in the production of any late roentgen changes. In the absence of such complications, a large metallic foreign body may remain benignly in lung tissue for apparently indefinite periods.[2,9,15] One writer[15] reported several cases of bullets lying in the lung without the formation of a fibrous tissue capsule around them; in the case of shell fragments we believe that a capsule is almost always present.

During the past three years we have made roentgen examinations of over 150 men with intrathoracic metallic foreign bodies from one to twelve months following injury. The vast majority of these were seen *between three and five months* following wounding, and several were observed for periods of another three months. Most of them were cases with intrapulmonary metallic foreign bodies, the fragments varying from less than 1 to as much as 40 mm. in length, and from 1 to 30 mm. in diameter. Approximately 25 per cent of the cases had fragments 1 cm. or over in diameter (a finding which is of some interest in view of d'Abreu, Litchfield and Hodson's opinion[3] that fragments of this size should be removed).

About 20 per cent of our cases had associated bony injuries, usually rib fractures, often healed by the time the patients were referred for roentgen examination at our hands. Approximately 75 per cent of the cases showed residual pleural changes (thickening, scarring and so forth). Only about 15 per cent showed pulmonary changes . . . . that is, pulmonary changes demonstrable with ordinary roentgen technique; with superlative technique the presence of fine pulmonary scars would undoubtedly have been shown in a much higher percentage of cases. Since such scars usually have no clinical significance, their detection cannot be regarded as very important. About 10 per cent of the cases showed no significant residual pleural or pulmonary changes.

Only a few of our cases had mediastinal or pericardial foreign bodies, and but one was intracardiac. None showed evidence of aortic or esophageal perforation. A few were intraosseous (rib or vertebra). The majority of the cases were due to shell or mortar fragments.

SYMPTOMS AND SIGNS

The late symptoms produced by intrathoracic metallic foreign bodies are extremely difficult to evaluate.[1,2,5,6,14] In general, if there is no secondary chronic infection and the patient is unaware

that he retains a missile, symptoms tend to be absent. Some patients complain of vague chest pain, hemoptysis, shortness of breath and so forth. If the fragment is near the periphery of the lung, thoracic pain might reasonably be ascribed to its presence, although we have seen several instances of such location without pain. Hemoptysis may apparently occur from some retained shell fragments; we recollect none in the present series. The evaluation of alleged dyspnea is almost impossible. As Blades and Dugan have pointed out,[1] such symptoms often disappear if the patient is shown the postoperative roentgenogram following removal of even a small foreign body!

Fairly severe clinical symptoms were evident in or were claimed by approximately 10 per cent of the cases in our series; slight symptoms by another 10 per cent and virtually no symptoms by the remaining 80 per cent . . . . provided their attention was not directed to the metallic object and leading questions were eschewed. These figures have some significance, since many of these patients were naturally anxious to secure release from military service and were apt to stress pulmonary symptoms. Almost all of them knew that they had scars on their chest walls and the majority suspected or knew they had received some intrathoracic fragments. The presence of severe associated injuries such as compound fractures of the arms or legs, penetrating abdominal lesions and facial injuries frequently served to distract the patient's attention from worrying adout a mild transitory cough or similar symptom.

Small, silent foreign bodies in the lungs are seen fairly often in civilian roentgenological practice. They commonly consist of pins, or needles and small calibre missiles. After the initial period is passed, and in the absence of complications, these small objects tend to remain unchanged and asymptomatic for an indefinite length of time. A few may migrate and cause subsequent pericardial, cardiac or other visceral disturbances.[6]

Large, *silent* intrathoracic metallic objects were considered to be a rarity, but we have now seen several such cases—jagged metallic objects as large as 3 cm. in diameter in patients without pulmonary symptoms, and whose films showed little or no scarring in the vicinity of the missile. The lung tolerates these quite well (in inverse proportion to the manner in which it tolerates organic substances such as clothing, *bone splinters*, etc.).

COMPLICATIONS

The early complications of intrathoracic metallic foreign bodies are well known and will not be discussed here. The late complications include migration and disintegration of the object, erosion

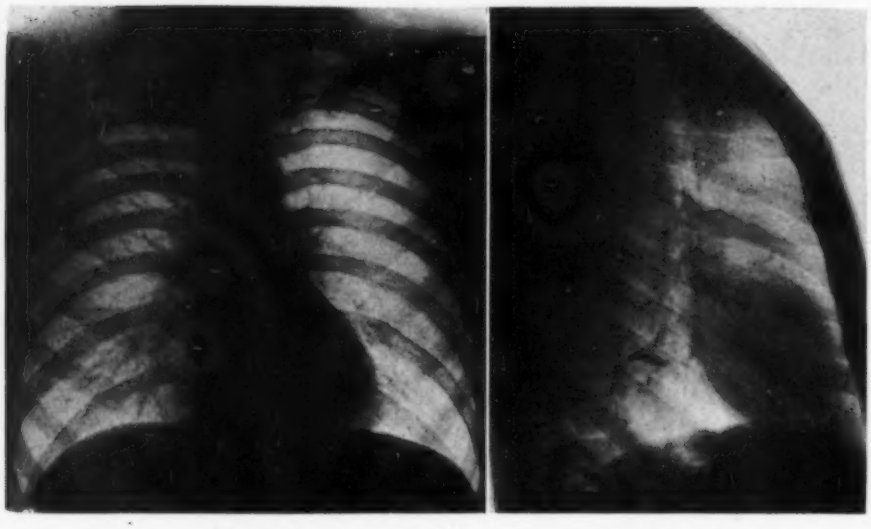

Figure 1A *Figure 1B*

Figure 1. (Case No. A2597): *Large, irregular intrapulmonary foreign body* (bomb fragment). Aviation Machinist's Mate, age 24, blown overboard aircraft carrier in March, 1945. Original diagnosis: Multiple wounds of chest and left lower leg, with compound fracture of tibia; rupture of left tympanic membrane. Hemopneumothorax.—Physical examination, July, 1945: Multiple healed shrapnel wounds over chest; healed incisional scar over the right tenth intercostal space and healed wound over the right seventh rib, anteriorly. No pulmonary findings.—X-ray (July, 1945): Metallic foreign body, 16x8x25 mm. in mid-portion of left lower lobe, without visible surrounding reaction; minimal thickening of some of the pulmonary markings in a small portion of this lobe.—Course: Complete resolution of hemopneumothorax; no chest symptoms at present time; patient sent on convalescent leave.

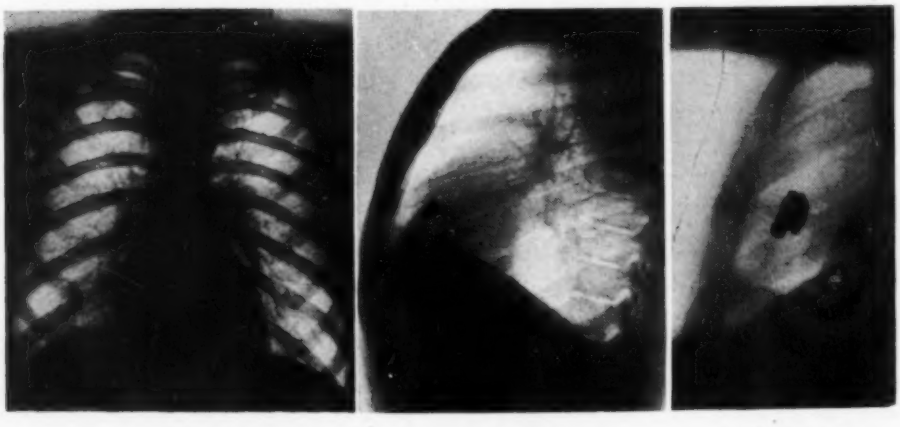

Figure 2A *Figure 2B* *Figure 2C*

Figure 2. (Case No. A1923): *Large, irregular intrapulmonary foreign body* (shell fragment). No significant pulmonary reaction now visible, despite fragment traversing the entire lower lobe and half of the adjacent middle lobe. Sergeant, age 26, wounded on board ship, March, 1945.—Physical examination, June, 1945: Negative, except for a scar on the right posterior thoracic wall.—X-ray (May, 1945): Metallic foreign body, 19x6x13 mm. in anterior portion of right middle lobe, without surrounding pulmonary reaction; slight pleural thickening around the inferior and lateral aspect of this lobe.—Course: Uneventful; returned to duty, June, 1945.

of blood vessels, recurrence of infection and the development of herniae (phrenic, mediastinal, etc). Pleural irritation, phrenic nerve pressure and so forth may also eventuate. Forsee et al.[7] describe pulmonary suppuration as a late complication of retained foreign bodies. We have seen no such instance.

Smooth slender objects may migrate and cause subsequent pleural, pericardial or other visceral disturbances, potentially grave. Therefore, should the patient have, for example, a smooth sharp-nosed bullet in the lung, it might be advisable to consider radiographing his lungs at annual intervals (or sooner if symptomatic) in order to observe early signs of migration.

Foreign bodies composed mostly or largely of lead may disintegrate after many years and be associated with symptoms of lead poisoning; we do not know of recorded instances of such occurring in connection with intrapulmonary objects, but have seen a few cases in connection with intramuscular or intraarticular lead

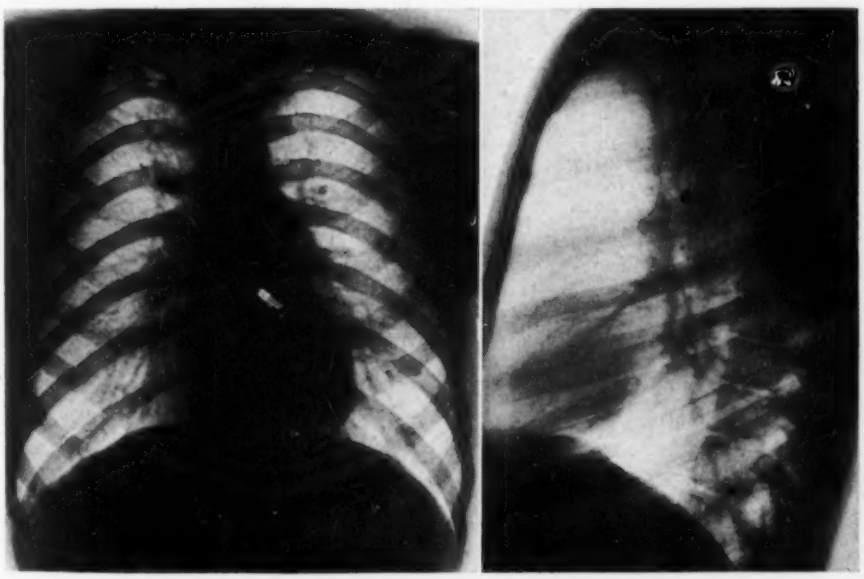

Figure 3A *Figure 3B*

Figure 3. (Case No. A1748): *Large, smooth intrapulmonary foreign body* (? 30 caliber bullet). Corporal, age 23, wounded on Iwo Jima, February, 1945. The bullet entered the *left* fourth intercostal space about 3 cm. to the left of the sternum. The patient had slight shock and hemoptysis but no respiratory distress.—Physical examination, April, 1945: Negative, except for the presence of a small healed scar at the point of entry.—X-ray (April, 1945): Bullet, about 30 caliber size, in right upper lobe near hilum, without visible surrounding reaction; fluoroscopic examination discloses no vigorous movement of this bullet; it is therefore presumably not in close relation to a large vessel.—Course: This patient had few symptoms and underwent prompt healing, despite the fact that the bullet must have traversed the mediastinum before ending up in the right upper lobe. He was ready for duty one month after the incident, but was returned to the continental limits for final study and disposition.

fragments. On the whole, this contingency must be extremely remote, since numerous persons have had small pieces of lead shot in their tissues for several decades and never shown clinical evidence of lead poisoning.

Erosion of blood vessel wall appears to be quite uncommon. We have seen one case of late, massive (and fatal) hemoptysis in a patient with a small intrapulmonary metallic fragment. The episode occurred following spontaneous rupture of a vessel wall damaged presumably by the passage of the object; at necropsy the latter did not lie near the torn vessel, and therefore the incident *cannot* be ascribed to the continued presence of the metallic foreign body in the lung.

One of the complications of penetrating injury reported in recent years is *extrapleural hemothorax*. In late cases such is rarely evident and would be difficult to differentiate such from intrapleural bleeding, pleural thickening and so forth. However, in early cases the following characteristics of extrapleural hemothorax have been reported: The effusion is almost always localized to a portion of the chest wall, and not spread diffusely up

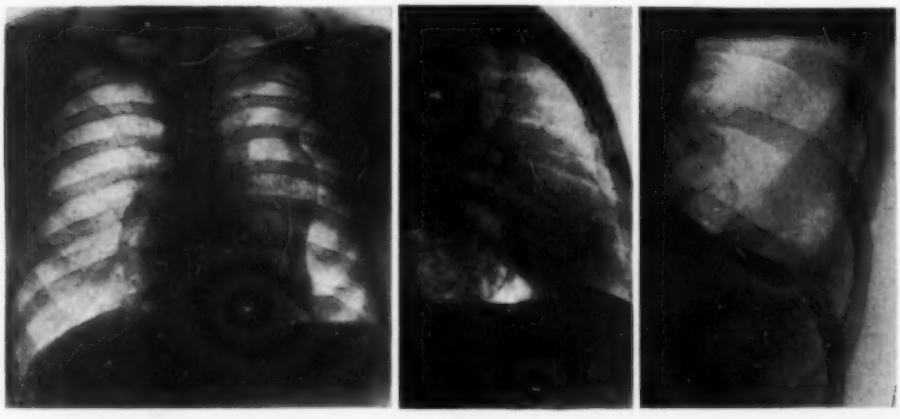

Figure 4A *Figure 4B* *Figure 4C*

Figure 4. (Case No. A1721): *Large, smooth subpleural (? phrenic) foreign body*—30 caliber bullet. Corporal, age 22, wounded at Iwo Jima, February, 1945. The bullet entered the left lower anterior chest about 2 cm. lateral to the midsternal line, at the sixth intercostal space; it presumably traversed the left lobe of the liver and the hemidiaphragm. Patient was unconscious for three days; had a bloody sputum for about a week and was given a diagnosis of blast concussion; he was described as moribund on evacuation.—Physical examination, April, 1945: Evidence of left hydro-pneumothorax; healed scar over left lower anterior thorax. —X-ray (April, 1945): Large, smooth metallic foreign body imbedded in or close to the posterior one-third of the left hemidiaphragm; fixation of the latter. Left hydropneumothorax, with about 50 per cent collapse of the lung; dense pleural thickening around left lower lobe, with adhesions. Barium examination of esophagus and stomach revealed no abnormality.—Course: After an initial stormy period, with massive hemothorax, he slowly improved. He was given much oxygen, plasma, penicillin, and so forth; he developed some complications, including apparent rupture of a left subphrenic abscess into the splenic flexure of the colon. In September, 1945, he was convalescent and in good shape.

or down. Its margin may arise gently or abruptly; in the latter instance it may give the appearance of overhanging at its inferior margin. Such a lesion will indent the lungs, sometimes for several centimeters. When located in a region such as the apex, it has a tendency to overlie the lung like a cap. It varies in size from a small "blister" to a large rounded collection, as much as 15 cm. in diameter. There is almost always some damage to adjacent ribs. Some cases may, of course, be accompanied by an intrapleural effusion or hemothorax.

A possible development which we have not experienced is the production of intrapulmonary arterio-venous fistula—from early or late erosion of the walls of adjacent pulmonary vessels.

REMOVAL

The question of the late removal of foreign bodies is apparently difficult to decide, despite the fact that most appear to be innocuous. Some authors[2,13] now believe that those in the outer two-thirds of a lung may be left alone, while those more centrally located should, in general, be removed. Antral (hilar), mediastinal and cardiac foreign bodies are more apt to be fatal and hence much less commonly seen than the first mentioned type,

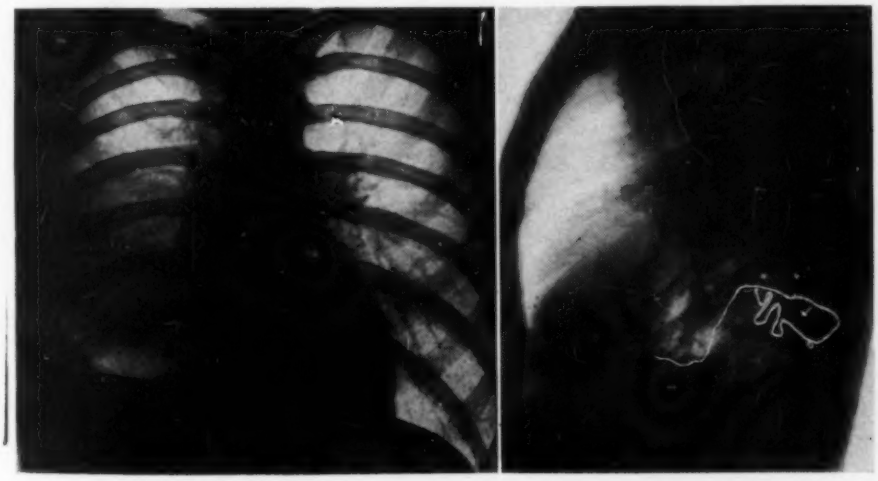

Figure 5A *Figure 5B*

Figure 5. (Case No. A1777): *Small, smooth intrapulmonary foreign body* (grenade fragment). Corporal, age 24, wounded by hand grenade in February, 1945. Developed hemothorax and hemoptysis, probably due to an associated rib fracture.—Physical examination, April, 1945: Multiple scars in right lower and posterior thoracic wall; physical findings of right pleural thickening.—X-ray (April, 1945): Three minute metallic foreign bodies in the posterior portion of the right lower lobe; multiple metallic fragments in the thoracic wall, right lower lateral and posterior. Pleural thickening, right parietal and basal. Healing fracture of right eighth rib in posterior-axillary line.—Course: His hemothorax was tapped only once and his bloody sputum ceased within a week. Convalescent in June, 1945.

especially in the later months after wounding. Holman[9] believes that the late removal of metallic foreign bodies in the lung depends largely on their size and whether the symptoms complained of may be attributed to their presence; those in the heart should be removed if symptom-producing.

Tuttle, Langston and Crowley[14] reported that during the African and Sicilian campaigns a size limit of 7 mm. was set as the criterion for removal, subject to restrictions of location; later, in the Italian campaign, the limits were gradually increased to 1.5 cm. (unless smaller fragments presented a menace to life). Incidentally, in direct contrast to King[11]—who found intrapulmonary abscesses around metallic foreign bodies in 4 out of 10 cases operated upon—Tuttle et al. found *no instance of lung abscess,* although the foreign body was often surrounded by a hematoma into which had been carried pieces of clothing, etc. In 68 cases with retained bodies, removal was deemed indicated in 44. Under combat conditions, early removal had poor results in 31 per cent of cases while late removal (after three weeks) had such in only 3 per cent. In summary, they believe that *the mere presence of even moderate-sized foreign bodies in the lung is not necessarily an indication for removal;* that symptom-producing bodies in the heart and lung should be removed; and that early removal is indicated in those involving the posterior mediastinum and diaphragm.

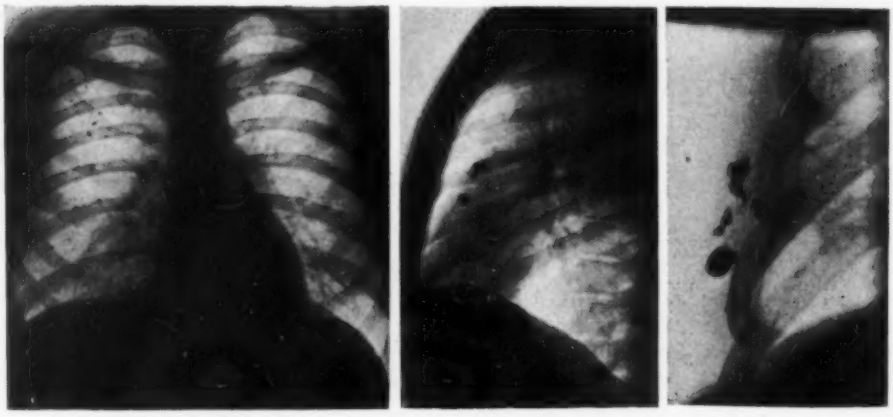

Figure 6A *Figure 6B* *Figure 6C*

Figure 6. (Case No. A1886): *Small, smooth intrapulmonary foreign body* (? explosive bullet fragments). Private, age 20, struck by sniper bullet on Iwo Jima, February, 1945. Developed "sucking" wound of chest, with massive right hemothorax and fracture of right fourth rib.—Physical examination, July, 1945: Essentially negative, except for small scar over right chest wall and evidence of pleural thickening.—X-ray (July, 1945): Multiple metallic foreign bodies in the right antero-lateral chest wall; pleural thickening around the right lung, notably laterally. Metallic foreign body, 10 mm. in diameter, in right lobe of liver. —Course: Following multiple thoracentes of bloody fluid, transfusions and etc., the patient improved steadily. Returned to duty July, 1945.

In a group of ninety-two patients with "acute" intrathoracic metallic fragments or bullets recently reported by d'Abreu et al.,[5] fifty were subjected to immediate operation "because of the danger of infection, hemorrhage and additional structural damage." Foreign bodies were removed from the lung in one-half the cases, from the pleural cavity in fourteen and from the mediastinum or pericardium in seven; in the remaining four they were removed from the "endothoracic fascia". There was a mortality of 4 per cent.

On the other hand, Nicholson and Scadding[13] report 15 cases with *retained intrathoracic metallic foreign bodies for periods exceeding 12 months,* only one of whom had symptoms (hemoptysis, apparently due to a large shell fragment), and *eleven of whom were still on active duty:* the other three had been discharged (no reason given).

Blades and Dugan[1] "endeavor to individualize each case" in the light of the following factors: (1) whether the fragment in the lung produces symptoms, (2) the size and position of the fragment, and (3) the psychosomatic effect on the patient who knows he has a shell fragment in his lung. They state that they believe

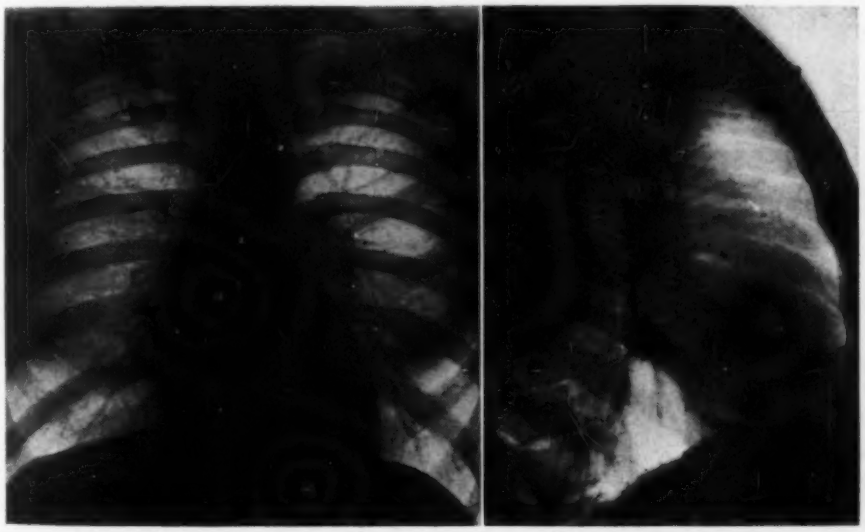

Figure 7A *Figure 7B*

Figure 7. (Case No. A1823): *Small, irregular intrapulmonary foreign bodies* (mortar shell fragments). Sergeant, age 26, wounded in March, 1945—multiple small wounds in chest wall and left thigh.—Physical examination, June, 1945: Chest negative, except for two small scars in the left upper anterior thoracic region.—X-ray (May, 1945): Two tiny metallic foreign bodies in left upper lobe at level of third space anteriorly; one moderate-sized fragment in subcutaneous tissues over manubrium sterni. Lungs otherwise clear.—Course: Despite the minute nature of the fragments and the relatively light nature of the injury, this patient allegedly developed severe dyspnea and chest pains lasting for some weeks following the injury. The small subcutaneous fragment was removed in June, 1945, and his chest was clinically well in September of that year. Sent to convalescent hospital.

that "size alone is not a reliable criterion on which to base the decision to remove a foreign body," and yet add "obviously, the large shell fragment should be removed". Of 30 patients with intrapulmonary shell fragments observed at Walter Reed General Hospital, 16 were subjected to surgical removal thereof. Of these only 12 showed "definite signs or symptoms which could be attributed to the foreign body," while 4 showed symptoms "probably psychosomatic in origin". In the remaining 14 cases in which operation was not advised the fragments "were small, in most instances multiple, and the patients had no complaints".

After observing the late cases reported in this article, it is our impression that the vast majority of intrapulmonary metallic foreign bodies do not require removal. In passing, it is rather curious but interesting to note that several authors[5,10] report that calcified nodes may easily be mistaken for metallic foreign bodies both prior to as well as at operation.

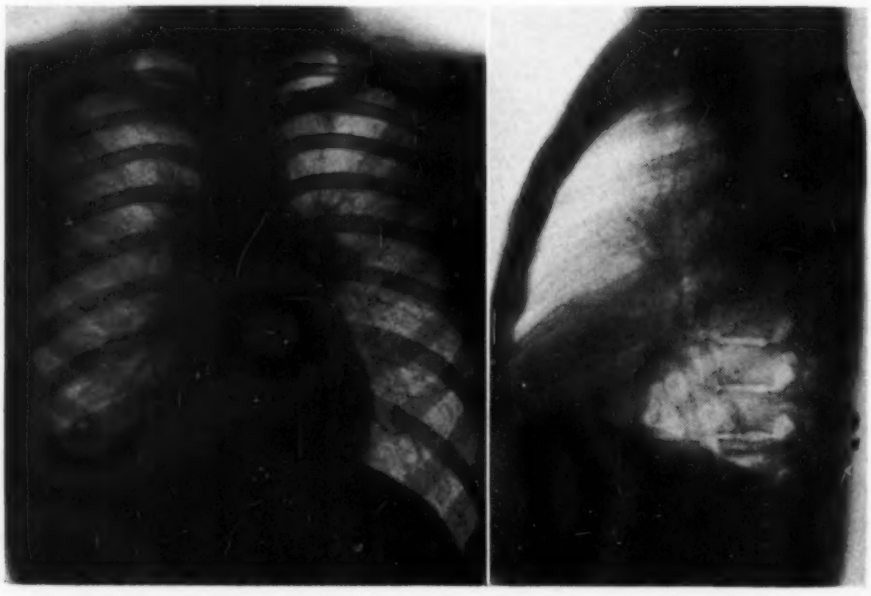

Figure 8A *Figure 8B*

Figure 8. (Case No. A2578): *Small, irregular extrapulmonary foreign body* (bullet fragment). Private, age 23, with gun shot wound of right side of chest sustained at Okinawa, June, 1945.—Physical examination, July, 1945: Healed scar, 3 cm. long, on right thoracic wall just below and lateral to the inferior angle of the scapula. Evidence of thickened pleura around right lung.—X-ray (July, 1945): Metallic foreign bodies in subcutaneous tissues behind and on right side of 10th and 11th thoracic vertebral bodies; thickening of the markings (scarring ?) in right middle and lower lobe; thickened pleura around these lobes.—Course: Immediately after injury, the patient's wound was debrided but the pleura not entered. He had hemoptysis for two days and x-ray evidence of right hemothorax, but no thoracentesis done. Clinically well in August, 1945, and sent on convalescent leave.

ILLUSTRATIVE CASES

The roentgenograms of a series of ten illustrative cases with intrathoracic metallic foreign bodies and penetrating wounds of the thorax are reproduced with this paper. The legends attached to the prints give the essential clinical and roentgenological data on all cases and, for purposes of brevity, these data will not be repeated in the text. Nine of the ten cases shown had, at the time of our particular roentgen examinations, normal blood counts, normal sedimentation rates, negative urine findings and negative laboratory findings of other types. Only one case, No. A1721, who had a residual hydropneumothorax, showed an elevated white count and a slightly increased sedimentation rate at the time of our examination.

SUMMARY

Intrathoracic (pulmonary) metallic foreign bodies are frequently innocuous, especially in the late stages (three or more months following injury).

These foreign bodies may have little or no associated pleural or

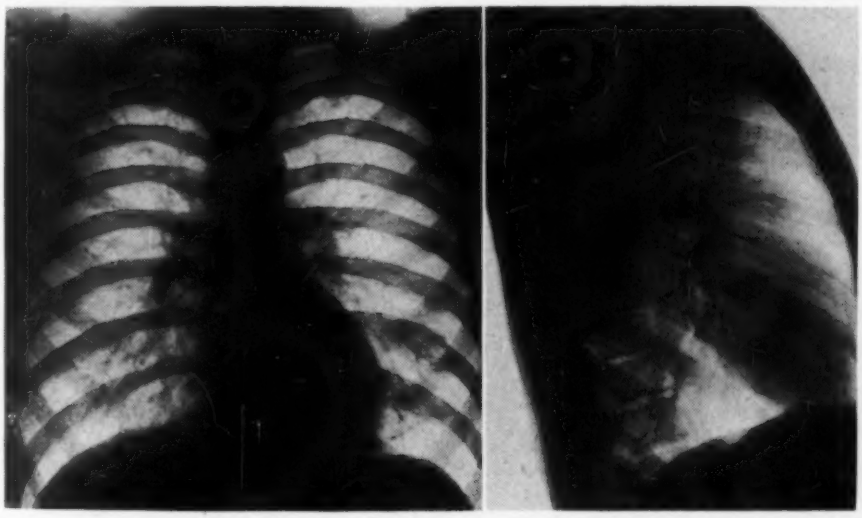

Figure 9A *Figure 9B*

Figure 9. (Case No. A1885): *Penetrating, through-and-through lung injury* (bullet). Private, age 21, was sustained a gun shot wound of the chest at Iwo Jima in March, 1945. Bullet entered left chest in posterior-axillary line near inferior angle of scapula, emerging near the mid-line posteriorly.—Physical examination, May, 1945: Small, healed scar in left lateral and posterior thoracic region. Evidence of pleural thickening at the left base.—X-ray (May, 1945): No metallic foreign body visible; lungs clear; slight posterior elevation of left hemidiaphragm presumably due to adhesions. Healing or healed fracture of left ninth rib.—Course: Patient developed a left hemothorax after the injury, requiring multiple thoracenteses and transfusions. The intercostal artery was presumably severed. Complete recovery by June; returned to duty in July, 1945.

pulmonary scarring, and, even though in close proximity to a large bronchus, often have no associated pulmonary symptoms.

The necessity for removing most metallic intrapulmonary fragments merely because they measure 1 cm. or more in diameter is not borne out by the series of cases reported herewith.

Organic material (notably bone fragments) driven into the lung at the time of injury, is apparently a much greater source of potential trouble than the metallic foreign body itself.

RESUMEN

Los cuerpos extraños metálicos intratorácicos (pulmonares) son frecuentemente innocuos, especialmente en los períodos avanzados (tres meses o más después del traumatismo).

Estos cuerpos extraños pueden estar acompañados de poca o de ninguna cicatrización pleural o pulmonar y, aun cuando están muy próximos a un bronquio grande, frecuentemente no causan ningún síntoma pulmonar.

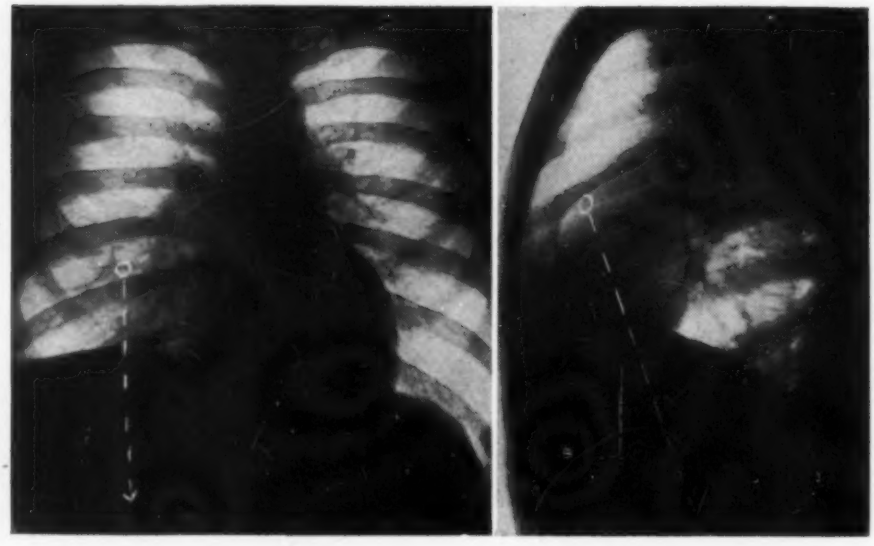

Figure 10A *Figure 10B*

Figure 10. (Case No. A1922): *Penetrating through-and-through lung injury* (bullet). Private, age 22, hit by sniper bullet on Iwo Jima in March, 1945. The bullet entered the chest 3 cm. mesial to the right nipple and ranged downward; no wound of exit could be seen.—Physical examination, July, 1945: Small, healed scar over right anterior chest: healed mid-line abdominal scar: evidence of pleural thickening at right base, anteriorly.—X-ray (July, 1945): No metallic foreign body visible. Right basal pleural thickening especially anteriorly and laterally. Lungs otherwise clear.—Course: The patient given an emergency laparotomy for hemorrhage; laceration of the liver was found and sutured, and a bullet in the peritoneal cavity removed. He showed steady improvement and returned to duty in July, 1945.

(The dotted line in the illustrations indicates the estimated course of the bullet; note the complete absence of pulmonary scarring.)

La necesidad de extraer la mayor parte de los fragmentos metálicos intrapulmonares simplemente porque midan un centímetro o más en diámetro, no se constató en la serie de casos incluídos en este informe.

Materias orgánicas (especialmente fragmentos de huesos) que penetren el pulmón con el cuerpo extraño metálico durante el traumatismo, aparentemente pueden ser causa de mucho más daño que el cuerpo extraño mismo.

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Comments from Other Countries

ARGENTINA

The practice of curative and preventive medicine in the Republic of Argentina has received immense benefits from Roentgen's discovery. The Argentine physicians have contributed to the progress of radiologic diagnosis by means of the application of new procedures and techniques; among others, perirenal insufflation (Carelli), the use of lipiodol in transuterine salpingography (Heuser), in the exploration of the salivary glands (Uslenghi); bronchography by intranasal instillation (Besavilbaso), bronchography by post-lingual instillation (Vaccarezza); operative biliary duct radiography (Mirizzi), anguloscopy (Enquin), diagraphy and recently tomography in metametric sections (Pollitzer), without enumerating numerous signs and radiodiagnostic interpretations.

RAUL F. VACCAREZZA, M.D., F.C.C.P., *Governor*
Buenos Aires, Argentina.

AUSTRALIA

As we commemorate the 50th anniversary of the discovery of the x-ray by Wilhelm Konrad Roentgen, it is with deep gratitude that we humbly do so, as his discovery has been of paramount importance to the whole medical world as a diagnostic aid.

During the second World War mass radiography has been a boon to both the Forces and Civilian population. Portable units have been carried on active service, on land and afloat.

It will continue during the post war period to be one of the most valuable assets which we have.

J. H. BLACKBURN, M.D., F.C.C.P., *Regent*
Queensland, Australia.

Medical men in South Australia are glad of the opportunity of paying tribute to the memory and to the outstanding achievements of Wilhelm Konrad Roentgen. It is difficult at the present time to visualize the state of affairs that existed prior to the advent of x-rays. Diagnosis in many fields of medicine, but perhaps especially in diseases of the respiratory tract, would be a sad and sorry business without the invaluable assistance afforded by radiological examination. Medical progress in Australia has received a tremendous stimulus from the remarkable discovery of this great man.

D. R. W. COWAN, M.D., F.C.C.P., *Governor*
Adelaide, South Australia.

X-ray in Australia is now used with success throughout the length and breadth of this vast land.

Her radiologists, technicians and manufacturers have never wearied

in well doing and a noble band of pioneers gave their lives in sacrifice for suffering mankind.

Through its aid and their skill light has been forced into dark places, and in diagnosis and therapy the standards of the practice of medicine have soared to a point of excellence not envisaged at the turn of the century. In celebrating the 50th Anniversary of Roentgen's discovery, Australia can say that she had been worthy of it.

J. A. MURPHY, M.D.
Waterfall, Australia

From 1920, the x-ray has played an increasingly important role in Australia. A great stimulus to improved technique was provided in 1937 by a visit from the late Dr. Edward C. Jarman of the U. S. A. X-ray apparatus has been very largely American, or American inspired. The X-ray and Radium laboratory created by the Commonwealth Government at Melbourne University has been most helpful in the field of manufacture and in radiotherapy. Australia was one of the first countries to adopt, early in 1940, miniature (35 mm.) photofluorography of the chest as a routine for all recruits to the services.

HILARY ROCHE, M.D., F.C.C.P., *Governor*
Melbourne, Victoria.

BRAZIL

A new method for utilizing the x-ray examination of the chest was applied for the first time in Brazil by Dr. Manoel de Abreu. This method consists of photographing the fluoroscopic image, thereby making possible a mass examination of the chest. In our country this type of procedure has proved of great value in the early discovery and prophylaxis of pulmonary tuberculosis.

Among the pioneers of roentgenology in Brazil, we find Drs. Dodsworth, Duque Estrada and Manoel de Abreu. The first complete installation for x-ray diagnosis was in the Hospital Santa Casa de Misericordia in Rio de Janeiro in 1927. This was soon followed by a similar complete service which was installed at the General Polyclinic Hospital in Rio. Here too, the first deep x-ray unit was placed in service.

In 1938, with the help of Dr. Mac Dowell, Dr. Manoel de Abreu first applied his method of photographing the fluoroscopic image at the General Polyclinic Hospital of Rio de Janeiro. Shortly after, over one hundred similar installations, both stationary and mobile, were being used throughout Brazil in carrying out mass surveys for the detection of pulmonary tuberculosis. It is hoped that before long the entire population of Brazil will have been x-rayed. At present, it is only by this method that the fight against tuberculosis can be won.

PROFESSOR ALFONSO MAC DOWELL, F.C.C.P., *Regent*
Rio de Janeiro, Brazil.
DR. PAUL MARCHESE and DR. B. GRYNKRAUT
Polyclinic General Hospital
Rio de Janeiro, Brazil.

CANADA

The writer remembers as a boy, seeing a demonstration at the Canadian Institute in Toronto, where the bones in the hand were outlined distinctly by a certain ray produced apparently as an electric current passed through a vacuum in a large glass tube. The paternal parent's comment at that time was, "Son, you will see great value come of this."

In 1916, the Ontario Laennec Society at the invitation of C. F. Parfitt, then of Calydor Sanatorium, Muskoka, came to his institution for their annual meeting. James T. Case, then of Battle Creek Sanitarium, had been advising him concerning his new x-ray plant, presumably with black bass fishing on the side. At that meeting for the first time, we saw chest x-ray plates approaching our present-day perfection.

A very few years later, the same Charles Parfitt was heard to say: "We thought we had developed the technique of the physical examination to such a degree that we were finding the disease very early indeed, but now any good x-ray technician at the cross-roads, can find a small tuberculous lesion even earlier still."

When Canada entered World War II, she commenced taking an x-ray film of every soldier before enlistment. She was the only Allied Country to do so from the start. The story of the finding of 4,000 lesions demonstrable by x-ray in the first 400,000 volunteers, has been told elsewhere in this journal in the past year.

WILLIAM E. OGDEN, M.D., F.C.C.P., *Regent*
Toronto, Ontario.

The 50th anniversary of the discovery of the x-ray by Wilhelm Konrad Roentgen commemorates a great milestone in the practice of medicine and surgery.

Like all the civilized countries of the world, Canada welcomed heartily this new adjunct which revolutionized old conceptions and opened new avenues for study and investigation.

Members of the Canadian medical profession join sincerely and wholeheartedly in expressing a tribute of admiration and appreciation to the memory of Wilhelm Konrad Roentgen, a benefactor of humanity, a great scientist and an outstanding genius.

J. A. COUILLARD, M.D., F.C.C.P., *Governor*
Mont Joli, Quebec.

It will be recalled that during the First World War the physical findings of the chest, percussion and auscultation, were rated of greater importance than the roentgenological examination of the lungs. We were later to find out the fallacy of this view. Many of the recruits undoubtedly had tuberculosis at the time of enlistment, but physical examination alone, carefully as it was given, frequently failed to reveal latent as well as active disease in the lungs. The lesson learned has been taken to heart. At the beginning of the present war, the Department of National Defense wisely decided that all recruits enlisting in the Canadian Army should have an x-ray examination of the lungs before they were admitted to the service. The wisdom of this move is beyond dispute. The technical side of radiology has been vastly improved since the days of the last war, and it has been conclusively

demonstrated again and again in mass surveys, as well as by the hundreds of thousands of examinations on inductees into the army, that the x-ray is the surest method to rule out the presence of tuberculosis in the lungs. There is no question that it will be the accepted practice in the future to have whole communities, sick and well, examined by means of x-ray, for there is where prevention as well as cure has its first and greatest point of attack in the control of tuberculosis.

A. F. MILLER, M.D., F.C.C.P., *Governor*
Kentville, Nova Scotia.

Canada, with other nations, has taken advantage of the improvements in x-ray technique. We need only refer to the appreciation of its value in the examination of recruits in this war as compared with that in 1914-18.

In addition to its varied application in general medicine, the use of miniature films in mass surveys has opened up a new vista in the control and eradication of tuberculosis.

In particular, the introduction of the portable unit has enabled us to examine isolated communities, particularly the Indians, living hundreds of miles from organized districts, thus bringing to a much neglected group the benefits of this wonderful discovery.

HAROLD I. KINSEY, M.D., F.C.C.P., *Governor*
Toronto, Ontario.

COLOMBIA

In the past fifteen years Colombia's plans and aspirations developed around public hygiene, private hygiene and social aid. Among all the methods of diagnosis and control of disease, we can be sure that radiology has come to be indispensable in a short period of time. The greatest benefit in the use of x-ray has been obtained in the early diagnosis of tuberculosis by means of Abreu's radiographic method, in the classification of patients and the control of their treatment with radiography and radioscopy; radiological diagnosis of cancer; and its general use in teaching. It has had a special place in gastroenterology, neurology, orthopedics, urology, gynecology, and, in general, all the centers where we have attempted to do scientific work.

If the x-ray apparatus is so essential in the above-mentioned institutions, then it certainly deserves a prominent place in the offices of the physicians in the private practice of medicine. In Colombia the x-ray is used extensively not only by the physicians in the cities, but also by a large number of our provincial physicians.

CARLOS ARBOLEDA DIAZ, M.D., F.C.C.P., *Governor*
Bogota, Colombia.

COSTA RICA

Costa Rica has had the privilege of using the x-ray since 1904, thanks to the genius of Jose Brunetti, who acquired his knowledge and apparatus in the United States of America.

Its progressive application in all medical fields was fundamental to

the progress of the medical sciences in a manner unequaled by any other technical attainment.

In our specific field of phthisiology, the x-ray enabled us to learn of the development of pulmonary tuberculosis. It has aided us in the medical and surgical treatment of tuberculosis and other chest conditions. The early diagnosis of tuberculosis, which is so essential as a public health measure, and the success of the anti-tuberculosis campaign in our country, would not be possible without the legacy which Wilhelm Konrad Roentgen left to humanity.

RAUL BLANCO CERVANTES, M.D., F.C.C.P., *Governor*
San Jose, Costa Rica.

CUBA

The medical profession in Cuba was quick to grasp the importance of the new methods based on Roentgen's epoch-making discovery. Without doubt, every medical specialty in Cuba owes most of its progress to the x-ray. In the words of our eminent roentgenologist, Dr. Pedro L. Fariñas, we stand ever ready to take advantage of any new discovery in this field in behalf of the sick and suffering.

ANTONIO NAVARRETE, M.D., F.C.C.P., *Regent*
Havana, Cuba.

ECUADOR

The use of the x-ray by physicians in Ecuador dates back to May 24, 1908, when the department "Dario Morla" of the General Hospital of Guayaquil was organized. However, two years before this, Pablo Arturo Suarez in Quinto, and Emilio G. Roca and Juan F. Heinert in Guayaquil, had small equipment for their private practice. The apparatus of the "Dario Morla" was a "Gaiffe," installed and handled by Juan Verdesoto, with Jose Alavedra as an assistant. Since then, modern apparatus has been introduced and modern techniques have been used.

The radiologists who have contributed to the progress of this modern procedure are Verdesoto, Francisco Andrade, Julio Mata, Jorge Illingworth, J. Ricaurte, R. Teran Gostelle and others.

JUAN TANCA MARENGO, M.D., F.C.C.P., *Governor*
Guayaquil, Ecuador.

ENGLAND

It is very seldom that any discovery has a profound effect on every branch of medicine. We have had things like insulin affecting diabetes or liver affecting pernicious anaemia but Roentgen's discovery of X-rays has brought light to every avenue of Medicine and Surgery. With the wonderful improvements which have been made since the original discovery the physician can now see where before he was blind. Such a discovery is more a revolution than a mere advance.

SIR ALEXANDER FLEMING, M.D., F.C.C.P.
London, England.

MEXICO

The enormous advantages for the accurate, rapid and early diagnosis of disease in modern medicine obtained in all our countries by the multiform application of Roentgen rays cannot be over-emphasized.

People all over the world, whether suffering disease or not, cannot realize how much indebted they are to Roentgen. A tremendous number of lives have been saved through the benefit of his discovery.

DONATO G. ALARCON, M.D., F.C.C.P., *Regent*
Mexico City, Mexico.

REPUBLIC OF PANAMA

The advent of roentgenology marks in our country, as for all of humanity, a definite step forward in scientific progress that has made possible greater precision in the study, diagnosis and treatment in many fields of modern medicine.

The benefits received from this achievement continue to increase with the gradual widening of our knowledge of its possibilities, accentuating in this manner, even more, the eternal debt of gratitude we have for its discoverer.

AMADEO VICENTE MASTELLARI, M.D., F.C.C.P., *Regent*
Panama City, Republic of Panama.

PERU

Peru received the benefit of the great discovery of Roentgen in 1896, the year in which Professor Constantino T. Carvallo obtained the first x-ray equipment.

As a symbolical initiation of this event, x-rays were taken of the hands of Mr. Nicolas de Pierola, the first democratic president of Peru, and Mr. Ricardo Palma, the great traditionalist writer.

The first professorship in radiology in our official curriculum started in 1923, and the first professor was Dr. Esteban Campodonico. The present professor in the Nacional University of San Marcos is Dr. Oscar Soto.

Actually, the x-ray is used in Peru in every field of medicine and medical investigation, and the benefit which Peru receives from this discovery confirms our gratitude to the scientific genius of Wilhelm Konrad Roentgen.

OVIDIO GARCIA ROSELL, M.D., F.C.C.P., *Governor*
Lima, Peru.

SOUTH AFRICA

In common with older countries, South Africa has shared fully in the results of Roentgen's great discovery, the jubilee of which we now celebrate. As in the old world, the x-ray has here found its most important scope in the councils of physicians and surgeons. All our large hospitals are fully equipped with diagnostic as well as therapeutic units,

and work of the highest quality is being carried out. The most significant work depending on radiography is that of our Miners' Phthisis (silicosis) Bureau on the Witwatersrand Gold Mines. The correlation of clinical with radiographic findings has provided standards which have become the pattern for similar work in other countries. The striking results in the rapid lowering of the incidence of silicosis (64% in one 10-year period) are attributed to a more thorough understanding of the disease permitted by the use of the x-ray. But in many other directions, in art, in industry, in criminology, the x-ray is an indispensable aid. Our young steel industry and our old diamond mining organization depend upon its help and protection.

Editorial restriction limits this telegraphic form of communication and permits little more than a formal salute from South Africa to the memory and genius of Wilhelm Konrad Roentgen, the discoverer of the x-ray.

DAVID P. MARAIS, M.D., F.C.C.P., *Governor*
Cape Town, South Africa.

SPAIN

In 1896, Dr. C. Comas and Dr. A. Prio made their first attempts with x-ray in Barcelona, Spain. The significance that Wilhelm Konrad Roentgen's discovery has had in the progress of medicine in Spain has been enormous. The broad diffusion of the knowledge of radiology has been evidenced by the numerous International and National Congresses devoted to it since 1911 as well as the creation of Professorships in Radiology. The application of radiology to early diagnosis in pulmonary tuberculosis and the anatomical-clinical and pathogenetic interpretation of tuberculosis has permitted us to reach a progressive improvement in the results of its treatment. The benefits derived from Wilhelm Konrad Roentgen's discovery are incalculable.

LUIS SAYE, M.D., F.C.C.P.
Barcelona, Spain.

UNITED STATES POSSESSIONS

HAWAII

In probably no other field of medicine has the discovery of the x-ray by Wilhelm Konrad Roentgen played such an important part as in diseases of the chest. Without it we would still be unable to detect the presence of tuberculosis until it had reached the stage where treatment is prolonged and difficult.

With its help and particularly that of photofluorography, we are now engaged in a Territorial-wide project whereby every individual over fifteen years of age is being given the opportunity of having a chest x-ray. This will undoubtedly eventually result in having the majority of cases picked up in the early and easily treated stage of the disease.

WILLIAM F. LESLIE, M.D., F.C.C.P., *Governor*
Hilo, Hawaii.

PUERTO RICO

The death rate from tuberculosis in Puerto Rico has come down from 308 deaths per 100,000 population in 1934 to 215 in 1944, a decrease of 30 per cent in ten years. This remarkable lowering of the mortality rate is believed to have been due in large measure to the intensive antituberculosis campaign which was launched in 1934, based largely on the extensive use of the x-ray machine in diagnosis and as a guide in treatment. Before this campaign was started, not more than half a dozen physicians on the island had fluoroscopes in their offices. Now, the fluoroscope has become so popular that the practicing physician who does not own one suffers from an inferiority complex. The public has become used to x-ray examinations of the chest and demands them. The Health Department has fluoroscopes in the more important public health units, and is planning to have this equipment installed in all of them. During the last few years mass x-raying facilities have been on the increase. Two photofluorographic machines are now in use and two more have been ordered. The local antituberculosis association has recommended a plan to take 500,000 miniature films of the chest annually. This would be equivalent to x-raying one fourth of the island's population every year.

Puerto Rico has still the highest tuberculosis mortality under the American flag; but we feel encouraged by the progress of the past and have great faith in the future. Long and hard as is the fight ahead of us, we gain comfort from the fact that we have attained one of the main prerequisites to success in any antituberculosis campaign: we have made physicians and the public, *x-ray conscious*.

J. RODRIGUEZ PASTOR, M.D., F.C.C.P.
Santurce, Puerto Rico.

The discovery by Wilhelm Konrad Roentgen is the starting point of a new era in the history of medical sciences in Puerto Rico.

At the present time the x-ray is widely used in hospitals and private offices both in therapy and diagnosis. The number of lives that have been saved by this great discovery is countless.

Medicine in Puerto Rico, as everywhere else, has been gradually developing special senses. It already has sight in the form of the x-ray machine.

DAVID E. GARCIA, M.D., F.C.C.P., *Regent*
Hato Rey, Puerto Rico.

RALPH CHARLES MATSON

Past President

American College of Chest Physicians

1880 - 1945

RALPH CHARLES MATSON

1880 - 1945

"In the death of Dr. Ralph C. Matson there passed another of those several great physicians of Oregon, each of whom in his time made medical history to the advantage of humanity everywhere. Dr. Matson was an international authority on tuberculosis and chest surgery, and his contributions to this highly specialized science were many. Though to the layman the fact conveys little meaning, editorship of the magazine, "Diseases of the Chest," is to the initiate all the evidence needed of singular and recognized eminence in the indicated field. As editor of this American publication, Dr. Matson's recognition was world wide.

"Perhaps Dr. Matson's greatest benefaction to the Pacific coast residents was his conclusive proof that tuberculosis can be as effectively treated here as in a more favorable climate. One can readily imagine what this proof signified, and still does, to tuberculosis patients of modest means or none whatever. It was more than a reprieve; often it was the way to health again for those who must otherwise have felt themselves under sentence of death.

"Few knew that Dr. Matson, one of the most human of mortals, had been in ill health for several years—while he carried on his practice and research, presenting a cheerful countenance to the world, himself undaunted. It is with deep regret that we consider the departure of Dr. Matson—but with sentiments of profound gratitude to the man and his memory. He kept the faith brilliantly, gently, consistently; he fought a good fight. There is no way to repay him, save to remember."*

The above quoted from an editorial obituary appearing in the Morning Oregonian, Portland, Oregon, October 30, 1945, is a just appraisal and tender tribute to a great physician. It was written by "a gentleman of the old school" about one of the finest physicians of a great period in medicine. Physician, Surgeon, Soldier, Writer, Teacher, Humanist, "Dr. Ralph" was all these. Paragraphs could be written extolling his prowess in each category. No doubt many will be. His contributions to medical knowledge and particularly to thoracic surgery were many, and the perfection of the technique of intrapleural pneumonolysis has received international acclaim. He was an astute diagnostician, his medical and surgical judgement were keen and accurate, and he combined the two skillfully. His work with the British Expeditionary Force and later with the United States Army during and after the first World War was outstanding.

Many patients who do not know his name are living normal lives because he made collapse therapy an increasingly acceptable and tolerable procedure. Many surgeons now and in the future are indebted to him for his pioneer work in thoracic surgery.

I would like to speak of him as a friend and a teacher. He loved people and life. Life loved Dr. Ralph and gave him an infectious zest and joy. His patients loved him, his students liked and admired him and his colleagues liked, admired and respected him. He was a perfectionist, critical of his own efforts; he could be blunt in his criticism of incompetence or carelessness but had unbounded patience with those sincerely desiring to learn. Everyone tried a little harder, worked a

*Used with permission of The Oregonian, Portland, Oregon.

little longer, felt a great pride in accomplishment under the stimulus of his enthusiasm and dynamic personality. A thorough student, an excellent teacher, a great man, he will live long; because talents and skills like his do not die. Every student of medicine who came under his instruction—and they were many during his 42 years of teaching—will remember and keep alive a part of him as he applies a stethoscope to a chest and recalls Dr. Ralph's description and interpretation of the sounds he hears.

Every patient who enters the University State Tuberculosis Hospital in Portland will keep alive a part of him, for the establishment of a State Hospital for the surgical treatment of tuberculosis is the fulfillment of his vision and his efforts.

The University of Oregon Medical School has lost a good teacher—the medical profession has lost a friend. His work and his skill will continue in other hands. He will never be replaced. Grief is tempered with gratitude for having had him with us this long.

JAMES T. SPEROS, M.D.
Portland, Oregon

THE EVENING STAR, WASHINGTON, D. C., FRIDAY, JUNE 21, 1940

Chest Physicians Study Co-operation With Army, Navy

All Specialists in U. S. Would Aid Examinations Of Recruits, Under Plan

Plans for co-operating with the Army and Navy in giving physical examinations to those preparing to enter the military service in the event this country becomes involved in the war were discussed yesterday at conferences among medical advisers of the two branches of service, the Veterans' Administration and Murray Kornfeld, executive secretary of the American College of Chest Physicians.

Also taking part in the conferences were Dr. J. Winthrop Peabody, president of the District Tuberculosis Association, and the association's managing director, Mrs. Ernest R. Grant. Dr. Peabody is the only local member of the Military Affairs Committee of the American College of Chest Physicians.

Under contemplated plans all chest specialists of this country would be made available in an emergency. In addition to 600 member specialists of the college, a survey is to be made to determine the number of other physicians who would be available.

"The Government departments are agreed," Mr. Kornfeld said, "that the present knowledge and most modern methods of diagnosis be utilized in the examinations, and that the progress made since the World War in this Nation's fight against tuberculosis be safeguarded and maintained to its full extent.

"Men with contagious and infectious diseases must be eliminated from military service to prevent further spread. The costly errors of the World War, for which we still are paying nearly $7,000,000 a year for hospitalization alone, must be avoided. A permanent history record and X-ray pictures of every enlistment must be filed for future reference," Mr. Kornfeld asserted.

"WELL DONE"

The above news clipping reproduced from the Washington Evening Star recalls that the College was in the forefront as early as June, 1940 urging the military authorities to put an x-ray program into effect.

The routine chest x-ray has reduced tuberculosis in our armed forces and in industry, and it has made the American Public x-ray conscious.

The medical departments of our government are to be congratulated and complimented for their insistence on x-ray surveys to protect the health of the nation.

The Council on Military Affairs and Public Health of the American College of Chest Physicians has since brought to the College meeting the leading authorities from the U. S. Army, Navy, Veterans and Public Health Services to discuss the advances made by those Services in their efforts to control tuberculosis. Their reports have been published in "Diseases of the Chest".

Now that the war has been terminated, let us continue this fine practice of encouraging the chest x-ray of all civilians at regular intervals. Herein lies our opportunity for controlling and eventually eliminating tuberculosis.

CHARLES M. HENDRICKS, M.D., *Chairman*
Council on Military Affairs and Public Health.

College News

SEMI-ANNUAL MEETING, BOARD OF REGENTS

The Semi-Annual Meeting of the Board of Regents of the American College of Chest Physicians was held at the Hotel Gibson, Cincinnati, on November 11, 1945. A report of the proceedings of the meeting will be published in the next issue of "Diseases of the Chest".

College Chapter News

SOUTHERN CHAPTER

The Southern Chapter of the College held its annual meeting in conjunction with the annual meeting of the Southern Medical Association at Cincinnati on November 12, 1945. The following program was presented:

9:00 A.M. — Scientific Session

David W. Heusinkveld, M.D., F.C.C.P., Cincinnati, Ohio, presiding.

"Fifteen Years' Experience with Carbon Dioxide in the Management of Cough," Andrew L. Banyai, M.D., F.C.C.P., Wauwatosa, Wisconsin.

Discussion opened by Karl Schaffle, M.D., F.C.C.P., Asheville, North Carolina, and Walter E. Vest, M.D., F.C.C.P., Huntington, West Virginia.

"Lobectomy and Pneumonectomy in Pulmonary Tuberculosis," Duane Carr, M.D., F.C.C.P., Memphis, Tennessee, and John S. Harter, M.D., F.C.C.P., Louisville, Kentucky.

"Pulmonary Resection for Tuberculosis"—With Slides and Motion Pictures, Richard H. Overholt, M.D., F.C.C.P., Brookline, Massachusetts.

Discussion of the above two papers opened by Maurice G. Buckles, M.D., F.C.C.P., Louisville, Kentucky, and Richard Kyle Brown, M.D., F.C.C.P., Greenville, South Carolina.

British Sound Film "Surgery in Chest Diseases," loaned by the British Information Services, Atlanta, Georgia.

12:30 P.M. — Hotel Gibson

Luncheon Meeting, Southern Chapter, American College of Chest Physicians, Alvis E. Greer, M.D., F.C.C.P., Houston, Texas, President, presiding.

Business Meeting, Reports of Committees, Election of Officers.

2:00 P.M. — Scientific Session

H. I. Spector, M.D., F.C.C.P., St. Louis, Missouri, presiding.

"A New Concept of the Treatment of Allergy,"—With Special Reference to the Treatment of Asthma and Migraine, W. Merritt Ketcham, M.D., Kansas City, Missouri.

Discussion opened by Carl C. Aven, M.D., F.C.C.P., Atlanta, Georgia and Dean B. Cole, M.D., F.C.C.P., Richmond, Virginia.

"The Geographical Distribution of Histoplasmin Sensitivity," M. L. Furcolow, M.D., Kansas City, Kansas.

"Histoplasmin Sensitivity in Relation to Pulmonary Calcification," Henry B. Zwerling, M.D., Bethesda, Maryland.

Discussion of above two papers opened by Herbert L. Mantz, M.D., F.C.C.P., Kansas City, Missouri, and Myron D. Miller, M.D., F.C.C.P., Columbus, Ohio.

"Pulmonary Coccidioidomycosis," Captain H. E. Bass, F.C.C.P., Burns General Hospital, Santa Fe, New Mexico.

Discussion opened by Captain H. R. Barnes, F.C.C.P., Denver, Colorado, and Merle D. Bonner, M.D., F.C.C.P., Jamestown, North Carolina.

7:00 P.M. — Hotel Gibson

Dinner Meeting, Charles M. Hendricks, M.D., F.C.C.P., El Paso, Texas, President-Elect, American College of Chest Physicians, presiding.

President's Address, Alvis E. Greer, M.D., F.C.C.P., Houston, Texas, President, Southern Chapter.

X-ray Conference, John M. Preston, M.D., F.C.C.P., Columbia, South Carolina, Conductor.

Officers and Committees

Southern Chapter

American College of Chest Physicians

President, Alvis E. Greer, M.D., F.C.C.P., Houston, Texas

First Vice-President, Carl C. Aven, M.D., F.C.C.P., Atlanta, Georgia

Second Vice-President, Paul A. Turner, M.D., F.C.C.P., Louisville, Kentucky

Secretary-Treasurer, Benjamin L. Brock, M.D., F.C.C.P., Waverly Hills, Kentucky

Program Committee

Paul A. Turner, M.D., F.C.C.P., Louisville, Kentucky, *Chairman*
Herbert L. Mantz, M.D., F.C.C.P., Kansas City, Missouri
Karl Schaffle, M.D., F.C.C.P., Asheville, North Carolina
John M. Preston, M.D., F.C.C.P., Columbia, South Carolina

Medical Education Committee

R. G. McCorkle, M.D., F.C.C.P., San Antonio, Texas, *Chairman*
Wm. Atmar Smith, M.D., F.C.C.P., Charleston, South Carolina
George R. Meneely, M.D., F.C.C.P., Nashville, Tennessee

Membership Committee

Carl C. Aven, M.D., F.C.C.P., Atlanta, Georgia, *Chairman*
Hollis E. Johnson, M.D., F.C.C.P., Nashville, Tennessee
H. I. Spector, M.D., F.C.C.P., St. Louis, Missouri

General Arrangements Committee

Benjamin L. Brock, M.D., F.C.C.P., Waverly Hills, Kentucky, *Chairman*
James L. Mudd, M.D., F.C.C.P., St. Louis, Missouri
W. F. Rienhoff, Jr., M.D., Baltimore, Maryland
Sidney Jacobs, M.D., F.C.C.P., New Orleans, Louisiana
Jesse Dean Riley, M.D., F.C.C.P., State Sanatorium, Arkansas
Sam E. Thompson, M.D., F.C.C.P., Kerrville, Texas

Local Arrangements Committee

John H. Skavlem, M.D., F.C.C.P., Cincinnati, Ohio, *Chairman*
James N. Christiansen, M.D., F.C.C.P., Cincinnati, Ohio
David W. Heusinkveld, M.D., F.C.C.P., Cincinnati, Ohio
William H. Lippert, M.D., F.C.C.P., Cincinnati, Ohio
Louis B. Owens, M.D., F.C.C.P., Cincinnati, Ohio
Charles M. Siegel, M.D., F.C.C.P., Cincinnati, Ohio
*Charles J. Farrell, M.D., F.C.C.P., Covington, Kentucky

*Chairman, Housing Committee.

ROCKY MOUNTAIN CHAPTER

The Rocky Mountain Chapter of the American College of Chest Physicians held its annual meeting at Denver, Colorado in conjunction with the annual meeting of the Colorado State Medical Society on September 19, 1945. The following program was presented:

9:00 A. M.

Pulmonary Coccidioidomycosis, Captain H. R. Barnes, F.C.C.P.
Pregnancy Complicated by Tuberculosis, Major E. A. Mechler.
Resection for Pulmonary Suppurative Disease, Captain C. B. Craft.
X-ray Studies in Unusual Chest Conditions, Major D. A. Dowell.

Noon — Luncheon and Business Meeting

Col. John B. Grow, MC, F.C.C.P., presiding
Guest Speaker, Minas Joannides, M.D., F.C.C.P., Chicago, Illinois.

Afternoon Meeting — 2:00 P. M.

British Sound Film, "Surgery in Chest Diseases," loaned by the British Information Services, Chicago, Illinois.
Actinomycosis of the Lungs, Captain H. E. Miller.
Diseases of the Esophagus, Major Herbert W. Schmidt.
Pulmonary Resection in Tuberculosis, Lt. M. L. Bradford.
Care of Recent Battle Wounds of the Chest, Major D. A. Mulvihill.
All of the speakers on the scientific program were from Fitzsimons General Hospital, Denver, Colorado.

Officers

Colonel John B. Grow, MC, F.C.C.P., Denver, Colorado, *President.*

Carl H. Gellenthien, M.D., F.C.C.P., Valmora, New Mexico, *First Vice-President.*

William C. Walker, M.D., F.C.C.P., Salt Lake City, Utah, *Second Vice-President.*

W. Bernard Yegge, M.D., F.C.C.P., Denver, Colorado, *Secretary-Treasurer.*

Regent, District No. 10

George B. Gilbert, M.D., F.C.C.P., Colorado Springs, Colorado.

Governors

Colorado: Arnold Minnig, M.D., Denver.
Utah: William C .Walker, M.D., Salt Lake City.
New Mexico: William H. Thearle, M.D., Albuquerque
Wyoming: H. R. Kanable, M.D., Basin.

Committees

General Arrangements Committee

W. Bernard Yegge, M.D., F.C.C.P., *Chairman*
G. Burton Gilbert, M.D., F.C.C.P.
William C. Walker, M.D., F.C.C.P.
John A. Cremer, M.D., F.C.C.P.

Nominating Committee

Arnold Minnig, M.D., F.C.C.P., *Chairman*
Charles Bundsen, M.D., F.C.C.P.
Aidan M. Mullett, M.D., F.C.C.P.

Reception and Entertainment Committee

Carl H. Gellenthien, M.D., F.C.C.P., *Chairman*
Alexius M. Forster, M.D., F.C.C.P.
John G. Wolf, M.D., F.C.C.P.
Maurice Chernyk, M.D., F.C.C.P.
Capt. H. M. Van der Schouw, M.D.

Scientific Program Committee

Colonel John B. Grow, MC, F.C.C.P., *Chairman*
Colonel G. F. Aycock, MC., F.C.C.P.
B. T. McMahon, M.D., F.C.C.P.
Capt. John G. Graham, MC.
Arthur Rest, M.D., F.C.C.P.

At the business session of the chapter, the following resolution was adopted: "The Rocky Mountain Chapter wishes to go on record as recommending to the Board of Regents of the American College of Chest Physicians the establishment of a Board of Diseases of the Chest, certifying specialists limiting their practice to chest diseases, without the requirement that they first be certified by the American Board of Internal Medicine."

Officers for the year 1945-1946 were elected. They are:

Carl H. Gellenthien, M.D., President
William C. Walker, M.D., First Vice-President
Capt. H. M. Van der Schouw, Second Vice-President
*W. Bernard Yegge, M.D., Secretary-Treasurer

*Re-elected.

Dr. Carl H. Gellenthien, President of the Rocky Mountain Chapter of the College announced the following committee appointments;

Membership Committee

W. B. Yegge, M.D., 227 16th St., Denver, Colorado, *Chairman*
C. D. Anton, M.D., 15 East Works St., Sheridan, Wyoming
A. M. Mullett, M.D., 23 E. Pikes Peak Ave., Colorado Springs, Colo.
I. D. Nelson, M.D., Indian San., Albuquerque, New Mexico
W. C. Walker, M.D., 829 Boston Bldg., Salt Lake City, Utah

Program Committee

Col. John B. Grow, Fitzsimons Gen. Hosp., Denver, Colo., *Chairman*
Robt. O. Brown, M.D., Sena Plaza, Santa Fe, New Mexico
Col. R. M. Hardaway, Bushnell Gen. Hosp., Brigham City, Utah

Public Relations Committee

Allan Hurst, M.D., Nat'l. Jewish Hosp., Denver, Colorado, *Chairman*
H. C. Jernigan, M.D., 106 S. Girard St., Albuquerque, New Mexico
Wm. R. Rumel, M.D., 54 E. South Temple, Salt Lake City, Utah

INDIANA CHAPTER

The Indiana Chapter of the American College of Chest Physicians held its annual meeting in connection with the annual meeting of the Indiana State Medical Society at French Lick, Indiana on November 6, 1945. The following program was presented:

Guest Speaker: Jerome R. Head, M.D., F.C.C.P., Chicago, Illinois, "Lung Resection in Pulmonary Tuberculosis."

This was followed by an x-ray conference and business meeting of the Chapter. The Tuberculosis Committees of the state and county medical societies in Indiana were invited to attend the meeting.

NEW YORK STATE CHAPTER

The following resolution was introduced by Dr. Nelson W. Strohm, F.C.C.P., Buffalo, Regent of the College for New York State, before the House of Delegates of the Medical Society of the State of New York and adopted:

WHEREAS: At the 1941 meeting of the House of Delegates a resolution by the House of Delegates recommending a symposium on chest diseases was approved and

WHEREAS: Such a symposium was given on chest diseases at a general session of the annual convention in 1942 and

WHEREAS: This general session was enthusiastically attended and appreciated, indicating the definite interest of the medical profession in the subjects presented and

WHEREAS: A certain chest disease, namely, tuberculosis, has almost become the forgotten disease and

WHEREAS: This disease which is the most common of all chronic chest diseases and is very amenable to care and treatment,

THEREFORE, BE IT RESOLVED: That the House of Delegates of the Medical Society of the State of New York establish a session on chest diseases for the next annual meeting.

ILLINOIS CHAPTER

The officers of the Illinois Chapter of the American College of Chest Physicians met in executive session at the Edgewater Beach Hotel, Chicago, October 9, 1945. The following officers and guests attended the meeting:

Officers

Fred M. F. Meixner, M.D., Peoria, President
Arthur S. Webb, M.D., Glen Ellyn, Secretary-Treasurer
Otto C. Schlack, M.D., Oak Forest, Past President
Minas Joannides, M.D., Chicago, Past President
Otto L. Bettag, M.D., Pontiac, Member
Kenneth G. Bulley, M.D., Aurora, Member
Paul H. Holinger, M.D., Chicago, Member
Edwin R. Levine, M.D., Chicago, Member

Guests

H. I. Spector, M.D., St. Louis, Missouri, Regent
Edward W. Custer, M.D., South Bend, Indiana

Dr. Webb introduced a motion that a two-day scientific program be presented by the Illinois Chapter of the College in connection with the 1946 annual meeting of the Illinois State Medical Society. The motion was seconded by Dr. Schlack and passed. Dr. Meixner appointed the following physicians to the Scientific Program Committee:

Kenneth G. Bulley, M.D., Aurora, *Chairman*
Otto L. Bettag, M.D., Pontiac
Edwin R. Levine, M.D., Chicago

The Committee was authorized to make all arrangements for the preparation and presentation of the scientific program for this meeting. It was further stipulated that invitations be extended to the members of the Indiana, Missouri and Wisconsin Chapters of the College to attend and participate in the meeting.

Dr. Levine proposed that the Illinois Chapter sponsor a postgraduate course at Chicago on diseases of the chest and the proposal was seconded by Dr. Holinger. The following committee was appointed to study this proposal and to submit a report to the Illinois Chapter at the next annual meeting:

Edwin R. Levine, M.D., Chicago, *Chairman*
Paul H. Holinger, M.D., Chicago
Minas Joannides, M.D., Chicago

Dr. Webb, Secretary of the Chapter, was appointed by the President to serve on all chapter committees.

NEW JERSEY CHAPTER

A delegation from the New Jersey Chapter of the American College of Chest Physicians attended the dedication of a library at the New Jersey State Tuberculosis Sanatorium, Glen Gardner, as a tribute to Dr. Samuel B. English, F.C.C.P., Medical Director of the Sanatorium. The New Jersey Chapter of the College made a contribution to the library fund.

PERUVIAN CHAPTER

The Peruvian Chapter of the American College of Chest Physicians held its annual meeting at the Asociacion Medica Peruana, September 13-15, 1945. The following scientific program was presented:

September 13

"Funcion social del mèdico en la lucha antituberculosa," Prof Ovidio Garcia Rosell, M.D., F.C.C.P.
"Problema asistencia del tuberculoso en el Hospital 'Daniel Carrion,' Callao," Luis E. Hubner, M.D., F.C.C.P.
"Investigacion del ambiente familiar de los niños internados en Collique," Pedro Zevallos A., M.D.
"Investigacion tuberculino-radiologica en grupo de embarazadas," Leopoldo Molinari Balbuena, M.D., F.C.C.P.
Preguntas y respuestas.

September 14

"Imagenes radiologicas pseudo tuberculosas," Prof. Juan A. Werner, M.D., F.C.C.P.
"Cuerpos fibrinosos intrapleurales en el curso del pneumotorax," Max Espinosa Galarza, M.D., F.C.C.P.
"Bronquiectasias en los niños," Horacio Cachay Diaz, M.D.
"Resultado del tratamiento por pneumo-serosa," Victor M. Tejada, M.D., F.C.C.P.
"Resultados en algunos casos de seccion de adherencia," Mario Pastor B., M.D.
Preguntas y respuestas.

September 15

"Estadistica sobre tuberculosis en algunos departamentos de la Republica," Luis Cano Gironda, M.D., F.C.C.P.
"Lues y tuberculosis—caso clinico," Juan Escudero Villar, M.D., F.C.C.P.
"Disgenesias bronco-alveolalares," Ramon Vargas Machuca, M.D., F.C.C.P.
"Aneurisma de la arteria pulmonar," Victor Narvaez, M.D.
Preguntas y respuestas.
Instalacion de la nueva junta Directiva.

The following officers were elected:

President, Max Espinoza Galarza, M.D., F.C.C.P.
Vice-President, Luis Cano Gironda, M.D., F.C.C.P.
Secretary, Ramon Vargas Machuca, M.D., F.C.C.P.
Treasurer, Luis E. Hubner, M.D., F.C.C.P.

Professor Ovidio Garcia Rosell, F.C.C.P., Governor of the College for Peru and President of the 7th Congreso Pan-Americano de la Tuberculosis (ULAST), visited Chile, Argentina, Bolivia and Uruguay in connection with the organization of the Congress which is scheduled to be held at Lima, Peru, January 25-31, 1947. Professor Garcia Rosell gave a number of lectures on tuberculosis during his stay in those countries.

Dr. Leo Eloesser, F.C.C.P., San Francisco, California, Vice-Chairman of the Council on Pan-American Affairs of the College, was a guest at a dinner given in his honor by the Peruvian Chapter of the College at Lima. Dr. Eloesser lectured at the Sociedad Peruana de Tisiologia.

Dr. Jorge Sarmiento Espejo, a member of the College, of Lima, Peru, is now visiting in the United States of America.

MEXICAN CHAPTER

Financial Report

	Pesos	*Dollars*
Cash received, June, 1944	488.02	101.25
Additional cash received, annual dues	123.70	25.00
Balance on hand, April 30, 1945	611.72	126.25

OCTAVIO BANDALA, M.D., *Secretary-Treasurer*
Mexican Chapter.

TUBERCULOSIS COMMITTEES MEET

The Tuberculosis Committee of the Minnesota State Medical Society held a meeting of the chairmen of the county tuberculosis committees at Minneapolis, on October 26. The meeting was called for the purpose of discussing plans for a state-wide tuberculosis control program by the medical profession. The National Council on Tuberculosis Committees of the College will study the minutes of the meeting and make a further report.

PHILIPPINE RELIEF

A notice was published in the September-October issue of the journal informing the College membership that a committee to administer relief to Fellows of the College in the Philippines was established by the Board of Regents. Our Philippine Fellows have been left homeless and penniless. We quote from a letter received from one of our Fellows in the Philippines:

> "The City of San Pablo was totally burned to ashes, including the church, the hospital, city hall, etc. My house was also burned including my pneumothorax clinic wherein I had two x-ray apparatus (50 MA & 100 MA), microscope, pneumothorax apparatus. surgical instruments, library, etc. All personal belongings of my family were also burned.
>
> "I have been fortunate enough for having gone to the mountains with my family and joined the guerrillas and have escaped the massacre of the Japs.
>
> "Dr. Angel Trinidad, one of our Fellows of the College, was not so fortunate. He was captured by the Japs and massacred. His family was left destitute.
>
> "I would like to request the help of the College in securing equipment so that I can re-establish a pneumothorax clinic. I am in need of x-ray equipment, pneumothorax apparatus, microscope and instruments. If the College can help me to secure this equipment and arrange terms for easy payment, agreeable to my poor situation, it would be fully appreciated."

Our Philippine Fellows are not asking for charity and have expressed a desire to pay for whatever equipment we can send them when they have the funds to do so. We appeal to the College members to send their contributions, either in used equipment or in cash, as promptly as possible to Dr. J. C. Placak, 10515 Carnegie Avenue, Cleveland 6, Ohio, Chairman of the Committee for Philippine Relief. The need is urgent, so please send in your contributions without delay.

CAPTAIN ALBERT KAPLAN AWARDED BRONZE STAR MEDAL

Captain Albert Kaplan, MC, U.S.N., served against the Japanese forces on Luzon, Philippine Islands, from 11 January to 30 June 1945. During this time Captain Kaplan served as Company Officer and Platoon Leader in the Clearing Company of an Infantry Division. In this capacity, Captain Kaplan, through untiring effort and application of superior professional skill effectively treated hundreds of wounded and sick patients and returned them to duty in a minimum of time. By virtue of a comprehensive knowledge of his assignment, Captain Kaplan personally supervised moving of equipment and establishing model stations in a most rapid and efficient manner. The constant devotion to duty displayed by Captain Kaplan reflects credit upon himself and the Medical Corps and was in keeping with the highest traditions of the military service.

Headquarters 25th Infantry Division
Office of the Commanding General
APO 25

MEMBERS OF THE COLLEGE RELEASED FROM THE ARMED SERVICES

Abrams, Maurice James, Major, M.C., 623 Bell Building, Montgomery, Ala.
Altschul, Frank J., Major, M.C., 177 Garfield Ave., Long Branch, N. J.
Applebaum, Irving L., Lt. Col., M.C., 31 Lincoln Park, Newark, N. J.
Ballenger, Irby B., Lt. Comdr. MC-USNR, 212 W. Central Ave., Albuquerque, New Mexico.
Castlen, Charles R., Lt. Col., M.C., 119 N. Central Ave., Glendale, Calif.
Cohen, Fred, Capt. M.C., 339 S. Third Street, Brooklyn, New York.
Brodie, Donald W., Capt. M.C., R.R. No. 2, Box 211, Indianapolis 44, Ind.
Cracovaner, Arthur J., Lt. Col. M.C., 103 East 78th St., New York, N. Y.
DePinto, Dominic A., Capt., M.C., 4938 W. Gladys St., Chicago, Illinois.
Fink, Ira, Major, M.C., 20 Park Avenue, New York, New York.
Gebauer, Paul W., Major, M.C., 3395 Scranton Road, Cleveland, Ohio.
Gerber, Joseph H., Major, M.C., Mt. Airy Road, Croton-on-Hudson, N. Y.
Haft, Dominic J., Capt., M.C., 3222 South May St., Chicago, Illinois.
Hennessy, James J., Lt. Comdr., MC-USNR, 50 Farmington Ave., Hartford, Conneticut.
Homan, Ralph H., Comdr., MC-USNR, 1200 1st. Nat'l. Bldg., El Paso, Tex.
Knoepp, Louis F., Lt. Col., M.C., 5900 Line Ave., Shreveport, Louisiana.
Kottke, Elmer E., Capt., M.C., 10847 Lindbrook Drive, Los Angeles, Calif.
Miller, Louis J., Major, M.C., 3215 West North Ave., Chicago, Illinois.
Ribaudo, Charles A., Capt., M.C., 301 East 21st Street, New York, N. Y.
Temples, Powell McRae, Lt., M.C., 178 Victoria Road, Spartanburg, S. C.
Tillou, Donald J., Lt. Col., M.C., 311 Church Street, Elmira, New York.
Weissman, Meyer T., Capt., M.C., 1139 E. Jersey Street, Elizabeth, N. J.
York, Jack Merrill, Capt., M.C., 36 Mentor Avenue, Painesville, Ohio.

Footnote: The Council on Military Affairs would appreciate receiving notices from the College members as soon as they are released from the armed services. Please address the Executive Offices of the College, 500 North Dearborn Street, Chicago 10, Illinois.

College News Notes

Dr. Carl H. Gellenthien, F.C.C.P., Valmora, New Mexico, presented a paper before the meeting of the Bernalillo County Medical Society at Albuquerque on September 12. The title of the paper was "Diagnosis of Pulmonary Tuberculosis."

Dr. Robert A. Peers, F.C.C.P., Colfax, California, has resigned as Mayor of Colfax, which position he has held since 1922. Dr. Peers was recently elected a member of the Board of Trustees of the American Medical Association. He is also Chairman of the Tuberculosis Committee of the California Medical Association.

Dr. William J. Habeeb, F.C.C.P., has been appointed Medical Director of the Clark County Tuberculosis Sanatorium, at Springfield, Ohio. Dr. Habeeb was formerly at the Pinecrest Sanitarium, Beckley, West Virginia.

At the request of the Victorian State Government, Australia, Dr. H. Maxwell James, F.C.C.P., Clinical Tuberculosis Officer, Public Health Dept., Melbourne, and Mr. C. J. Officer Brown have been visiting in the United States and Canada for the past several months. Dr. James is inspecting tuberculosis institutions in the United States and Canada and he will assist in planning the construction of tuberculosis sanatoria in the State of Victoria, Australia. Mr. Brown is visiting the thoracic surgery centers in the United States and Canada and observing the latest techniques in chest surgery.

Dr. Robert K. Campbell, F.C.C.P., Springfield, Illinois, celebrated his twenty-fifth year of service at St. John's Sanitarium on August 7, 1945. Both patients and staff of the hospital joined in the jubilee party.

Dr. Leo Eloesser, F.C.C.P., San Francisco, California, has been assigned as teaching specialist in surgery for the Chinese medical training program of the United Nations Relief and Rehabilitation Administration. The medical training program was planned jointly by UNRRA and CNRRA—the Chinese government relief agency—and is now rapidly getting under way.

Dr. Peter A. Theodos, F.C.C.P., formerly with the Army Medical Corps, has been transferred to UNRRA and is now stationed in Greece.

Lt. Col. Brian B. Blades, M.C., F.C.C.P., Washington, D. C., will present a paper entitled "Recent Advance in the Treatment of Chronic Empyema," and Dr. Edgar Davis, F.C.C.P., Washington, D. C., will present a paper entitled "Tumors of the Lung," at the Tenth National Assembly of the United States chapter of the International College of Surgeons, to be held December 6-8 at the Mayflower Hotel, Washington, D. C.

Dr. Vera V. Norton, Waverly, Iowa, Fellow Emeritus, American College of Chest Physicians, was honored by having the library at the Dunham Hospital, Cincinnati named for her. Dr. Norton was formerly on the staff of the sanatorium.

Positions Wanted and Available

MEDICAL SERVICE BUREAU

In accordance with a resolution adopted by the Board of Regents of the College at their annual meeting held in Chicago on June 17, 1945, a Medical Service Bureau has been established at the Executive Offices of the College for the purpose of serving the members of the College being released from the armed forces.

The Bureau would appreciate receiving information from the medical superintendents of sanatoria regarding positions available at their institutions, together with full particulars as to the type of position and salary offered. Fellows of the College who are looking for assistants should send complete information to the Bureau.

Physicians being released from the armed forces who are seeking appointments and positions should send complete information to the Bureau regarding their training and the type of position desired.

Please direct all correspondence to the Medical Service Bureau, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

POSITIONS WANTED

Fellow, American College of Chest Physicians, well trained and experienced in all phases of tuberculosis, desires position as medical director in a 200-300 bed sanatorium. Prefers either New England or California, but will go anywhere in the continental United States. Minimum salary $4,500 with complete maintenance. For further particulars, address Box 209A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Wanted, position in chest surgery in the west or southwest. Veteran, Associate Member, American College of Chest Physicians, 2 years thoracic surgical training, license in the state of Illinois. For further particulars, address Box 212A, American College of Chest Physicians, 500 North Dearborn St., Chicago 10, Illinois.

Veteran would like position in institution or private clinic. Experienced in tuberculosis treatment and other chest diseases. Can furnish good references. Married, 43 years old, graduated from Virginia Medical College in 1928. Please address Box 213A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Physician would like part-time position while establishing practice. Has been doing general practice, but spent some time in chest work while an interne. Would prefer some place in Chicago or along the North Shore. Please write Box 216A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Position wanted by veteran soon to be released from service. Experienced in tuberculosis field. Especially interested in associating with a progressive institution. For further information please address Box 218A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Associate Fellow, American College of Chest Physicians, veteran soon to be discharged from the service, experienced in thoracic surgery and bronchoscopy, desires position in sanatorium having proper housing facilities for wife and child, or with private medical group in private practice. Either full or part time. Please address Box 215A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Veteran of four years service, graduate of University of Maryland, 1937, resident in internal medicine three years, qualified for Boards, desires part time position in or near Chicago. For further particulars address Box 214A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Veteran, Loyola University School of Medicine graduate, 1940, four years medical service, would like residency in an approved hospital, or part time position in private practice. For further particulars write Box 211A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Veteran, graduate University of Illinois College of Medicine, 1943, some experience in chest diseases, desires part time position in private practice in or near Chicago. Would also consider residency in approved hospital. For further information write Box 210A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

POSITIONS AVAILABLE

Position available for Director of Division of Tuberculosis Control for the Seattle Department of Health, January 1, 1946. Applicant must be able to obtain license in the State of Washington; must have specialized tuberculosis training or experience in public health. Position is full time and pays $5,940 plus reimbursement for travel. Apply to Emil E. Palmquist, M.D., Commissioner of Health.

Junior physician wanted for sanatorium in east. Initial salary $2,040 annually plus maintenance. Should be experienced in tuberculosis sanatorium treatment. Will teach pneumothorax. Also, Senior physician, salary $2,880 annually with maintenance. Applicants may be married but without young children as quarters are inadequate. Class A medical school. Massachusetts license also desirable. For further information address Box 118A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Two physicians needed at 665 bed sanatorium in West Virginia who are trained in the treatment and management of adult, tuberculous patients. Salary starts at $225, with $25 raise each six months until $300 per month is reached, with full maintenance. For further particulars please address Box 117A, American College of Chest Physicians, 500 North Dearborn St., Chicago 10, Illinois.

Physician wanted for private chest clinic, knowledge of x-ray interpretation, pneumothorax experience and fairly well-rounded knowledge of tuberculosis treatment. House available for married physician. Must be eligible for Michigan license. Initial salary $600.00 per month. For further information address Box 120A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Position available in State Health Department. Physician who is experienced in chest work and is able to read chest x-ray films will be considered. For further particulars write Box 121A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Positions available for two physicians in 185 bed county sanatorium in Indiana. Institution is approved by the American College of Surgeons and is a member of the American Hospital Association. Facilities for training in thoracic surgery and bronchoscopy and an active out-patient service is maintained. Salary $150 to $350 per month in addition to maintenance for a small family. For further particulars address Box 122A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Four residencies in tuberculosis will be available in an eastern state tuberculosis sanatorium. Men and women physicians, single or married, will be accepted. Residents will receive an opportunity for good training in tuberculosis and other chest diseases, as 25 per cent of our admissions are non-tuberculous. Active collapse therapy and major thoracic surgery are maintained at the institution. Salary for untrained physicians begin at $175 per month plus complete maintenance. Married physicians with families can be housed. For further particulars write Box 123A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Positions available for qualified chest specialists in the Veterans Administration. For full particulars address the Acting Surgeon General, Veterans Administration, Washington 25, D. C.

Positions available for physicians in state sanatorium in the south. For further particulars address Box 124A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Ill.

DISEASES OF THE CHEST

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BUY CHRISTMAS SEALS — FIGHT TUBERCULOSIS

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A brief summary should be included for translation into Spanish.

FULL ADDRESS of author should appear somewhere on manuscript, preferably at the end.

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